Nuytsia

WESTERN AUSTRALIAN HERBARIUM
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Department of **Biodiversity, Conservation and Attractions**

The cover photo for Volume 36 features a species of smoke bush (*Conospermum unilaterale* E.M.Benn., Proteaceae) from near Eneabba, Western Australia. Image by Benjamin Anderson (2021).

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Nutysia

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Samolus intricatus (Primulaceae), a new species of Brookweed from semi-arid to arid-zone wetlands of north-western Western Australia

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SHORT COMMUNICATION

Flora surveys of the Fortescue Marsh (known as *Martuyitha* to the *Nyiyaparli* People and *Manggurdu* to the *Banjima* People) in the Pilbara region, Western Australia, identified a taxon of *Samolus* L. with an unusually divaricate and tangled habit that was subsequently assigned the phrase name of *Samolus* sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702). This taxon is part of a complex of several allied taxa that occur in the northern half of Western Australia and are currently assigned to either a varietal status of *S. repens* (J.R.Forst. & G.Forst.) Pers. or an informal name recognised on the Western Australian Plant Census (The Western Australian Herbarium 1998-). The morphological distinctiveness of this particular entity is sufficient to describe it here as a new species.

Samolus intricatus A.S.Markey, *sp. nov*.

Type: Fortescue Marsh, Western Australia [precise locality withheld for conservation reasons], 11 August 2013, *A. Markey, M. Lyons & C. McCormick* FM 9705 (*holo*: PERTH 08552207!; *iso*: AD, BRI, DNA, MEL, NSW).

Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702), Western Australian Herbarium, in *FloraBase*, https://florabase.dbca.wa.gov.au/ [accessed 4 November 2024].

Samolus sp. Great Sandy Desert SVL (2912), S. van Leeuwen, *Biological Survey of the south-western Little Sandy Desert,* p. 61 (2002), *nom. inval.*, *nom. nud.*

Upright, 0.30–1(–1.5) m tall, tufted to rounded perennial *subshrub* with many (> 10) robust stems arising from a clumped or linear, reddish rhizome, becoming intertwined with adjacent stems to form a much-branched, rounded and tangled cluster. *Stems* erect, wiry, terete, flexuose, tangled, lime-green, 0.6–2.6 mm wide, widest at bases, hairless but surfaces distinctly verrucose from being covered in minute, raised salt glands and scurfy from salt deposits, becoming distinctly wrinkled or scabrous when dry. *Lateral branches* alternate, arising from stem axes at a wide internal branching angle ranging from (40–)50–140°, then curving upwards parallel to the stem. *Basal leaves* caducous, absent in mature plants, present only in seedlings as a basal rosette of 5–25 (increasing in number with seedling development), sessile, obovate-spathulate, 10–25 mm long, 5–15 mm wide, fleshy, smooth, glabrous, sparsely scattered with salt glands; apex obtuse to truncate; margins entire; midrib indistinct or barely discernible. *Cauline leaves* scattered along stems, reduced to scales, sessile, triangular to broadly triangular, 0.7–1.5(–2.0) mm long and 0.9–1.7 mm wide on upper stems, and 1.0–2.1(–3.0) mm long and 0.5–0.9 mm wide on lower stems; apex acute, deflexed and hooked on upper stems, adpressed and regularly breaking off on lower

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stems; lacking a midrib, glabrous, developing from green to scarious and brown. *Inflorescence* a terminal raceme of 3–7(–9) flowers, 1.0–4.6(–6.0) cm long. *Pedicels* hairless, scurfy, lime-green, covered in salt glands, 2–8(–10) mm long, 0.3–0.7 mm wide, becoming progressively shorter towards top of raceme, emerging from raceme axis at a wide angle of 50–120° before curving upwards, with a single scale-like, light brown bract 0.7–1.2 mm long, adnate to the pedicel at positions varying from near the base to the middle. *Flowers* actinomorphic. *Calyx* campanulate, green, glabrous, verrucose with many minute raised salt glands and appearing scurfy from salt crystals, ratio of calyx lobes:tube length 0.8–1.0. *Calyx tube* (hypanthium) (0.9–)1–2(–2.2) mm long, lengthening in fruit. *Calyx lobes* 5 (occasionally 6 or 7), triangular or triangular-ovate, 1.0–2.0(–2.3) mm long, (0.8–)1.0–1.5 mm wide; margins minutely hyaline; apex acute or minutely mucronate. *Corolla* regular, white, glabrous, smooth, (3.0–)4.0–6.5 mm long, fused at base into a *tube* 1.5–3.0(–3.2) mm long. *Corolla lobes* 5 (occasionally 6 or 7), spreading, narrowly elliptic to narrowly oblong, (1.7–)2.0–3.6(–3.8) mm long, (1.2–)1.5–2.2 mm wide; apex obtuse to rounded. *Ovary* half inferior, glabrous, ovoid, 2–3 mm long. *Ovules* many (> 50). *Style* terminal, glabrous, white, 2.0–4.0(–4.5) mm long. *Stigma* simple to discoid. *Stamens* 5, antepetalous, alternating with 5 antesepalous staminodes, both adnate to and exserted from mouth of corolla tube, held above deflexed corolla lobes. *Anthers* white to pale yellow, 0.8–1.7(–1.9) mm long, opening by introrse longitudinal dehiscence, topped by an apical process 0.2–0.4(–0.5) mm long. *Filaments* equal, white, glabrous, 1.1–2.0(–2.3) mm long. *Staminodes* white, filamentous, glabrous, (0.7–)1.0–1.5(–2.3) mm long, half to same length of and more slender than fertile filaments. *Fruit* an ovoid denticidal capsule, 3.3–4.7(–5.0) mm long and 2–3 mm wide, dehiscing apically by 4 or 5 (rarely 6) valves. *Seeds* many (> 50) per capsule, yellow-brown to red-brown, cuboid with angular walls and a reticulately patterned surface, 0.21–0.46 mm wide, 0.30–0.71 mm high. (Figures 1, 2)

Diagnostic characters. *Samolus intricatus* may be distinguished from all other members of the genus by the following combination of characters: divaricately branched stems that become interlaced and tangled, cauline leaves reduced to brown, dry and scarious scales < 2 mm in length, with scales along upper stems decurved with hooked apices and those along the lower stems adpressed and with their tips often breaking off, an absence of basal rosette of leaves in mature plants and the plant forming a rounded, densely branched shrub 30–100 cm tall.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 1 Oct. 2014, *J. Bull & D. Roberts* ONS F 221.01 (PERTH); 14 Oct. 2016, *J. Bull & J. Waters* ONS RF 60.01 (PERTH); 27 July 2007, *G. Byrne* 2792 (NSW *n.v.*, PERTH); 7 Sep. 2004, *R.J. Chinnock* 9793 (PERTH); 31 Aug. 2013, *A. Markey & R. Coppen* FM 10962 (PERTH); 16 Sep. 2013 *A. Markey & C. McCormick* FM 9704 (BRI, CANB, DNA, MEL, PERTH); 31 July 2013, *A. Markey, S. Dillon, M. Lyons & C. McCormick* FM 10964 (PERTH); 8 Aug. 2013, *A. Markey, S. Dillon, M. Lyons & C. McCormick* FM 10963 (PERTH); 11 Aug. 2013, *A. Markey, M. Lyons & C. McCormick* FM 9706 (PERTH); 8 Apr. 1990, *A.A. Mitchell* 1833 (PERTH); 27 July 1996, *A.A. Mitchell* PRP 1284 (PERTH); 30 Mar. 1984, *K.R. Newbey* 10084 (PERTH); 16 Oct. 1996, *S. van Leeuwen* 2912 (PERTH); 8 Sep. 2002, *S. van Leeuwen* 5167 (PERTH); 3 May 2014, *G. Wells s.n.* (PERTH).

Phenology. Flowering and fruiting occur from March to October, with fruit maturation and seed release occurring soon after anthesis. Flowers are fragrant and attract insect pollinators, including species of Blue-banded Bees (*Amegilla* sp.). Seeds are shed into the immediate surrounds, dispersed within the landform possibly by wind and/or water. Soil moisture is important for flowering, and plants along permanent pools will continuing flowering over several months. Plants on saline floodplain margins will recover from drought, grow vigorously and flower in response to floodplain and lake inundation events following summer cyclonic rainfall in the catchment.

Distribution and habitat. *Samolus intricatus* is known from only three locations in northern Western Australia, with its main distribution on the Fortescue Marsh (*Martuyitha / Manggurdu*) in the Pilbara and two disjunct, outlying areas in the Little Sandy Desert: one centred on the Beyondie Lake – Sunshine Lake region, and another location on the margin of Savory Creek (Figure 3). *Samolus intricatus* grows

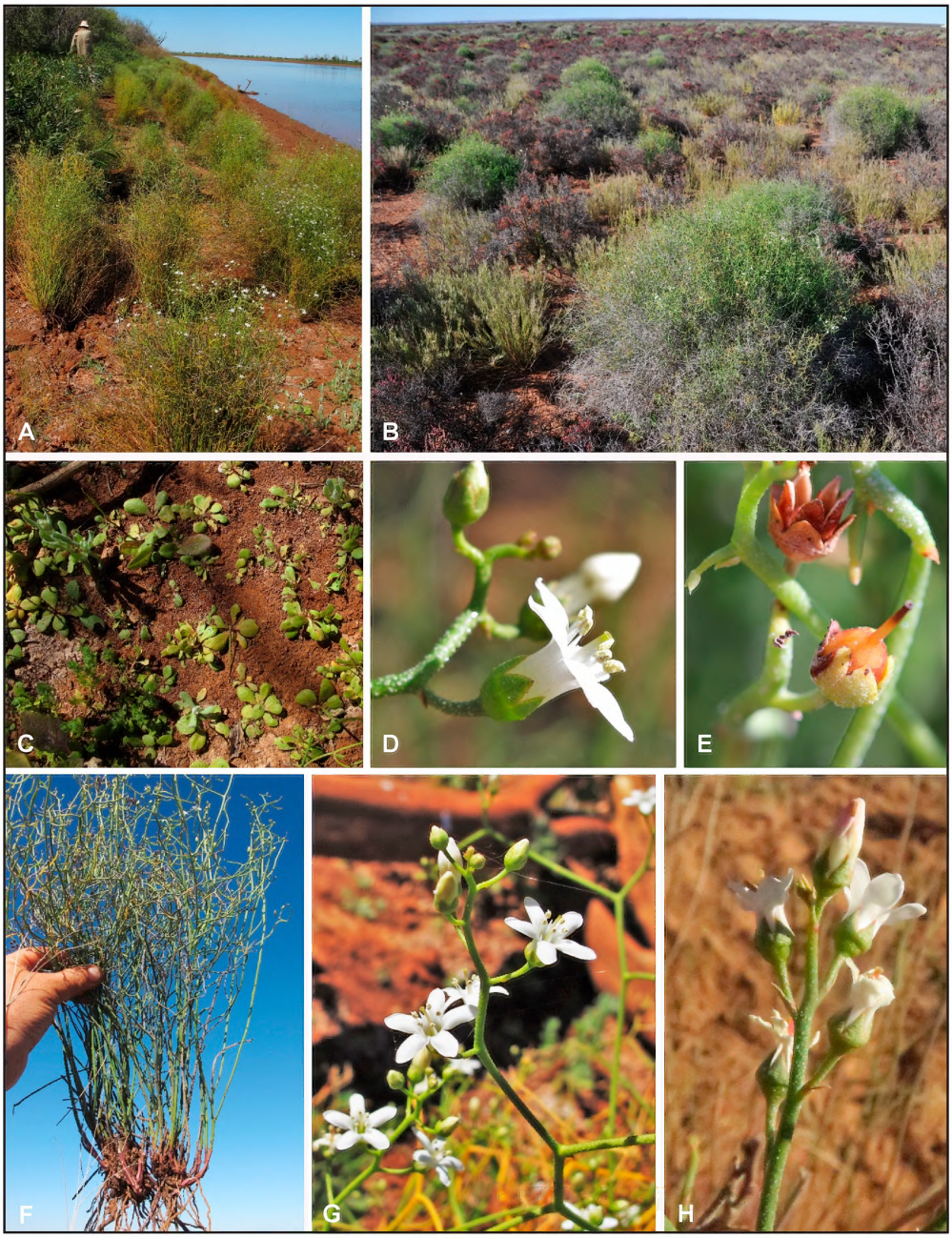

Figure 1. *Samolus intricatus*. A – plants along a permanent freshwater pool on the Fortescue Marsh, showing the erect, tangled, divaricate branching habit; B – green, rounded shrubs in samphire shrubland on Fortescue Marsh; C – seedlings, showing the rosette of basal leaves which subtend young stems; D – flower; E – fruit; F – mature plant, showing rhizome and stems with no basal leaves and tangled, divaricately branching stems; G – raceme showing upturned pedicels, wide branching angle and sinuous raceme; H – *Samolus* sp. Millstream (M.I.H. Brooker 2076) showing raceme with erect linear pedicels and comparatively straight rachis. Images from *A. Markey, M. Lyons & R. Coppen* FM 9706 (C), *A. Markey, S. Dillon & H. Robertson* FM 10964 (D), *A. Markey, S. Dillon C. M. Lyons & McCormick* FM 10963 (E), *A. Markey & R. Coppen* FM 9705 (F–G), and *A. Markey* LCVS 108 (H). Photographs by A. Markey (A, C–H) and Steven Dillon (B).

Figure 2. Herbarium specimens illustrating A – the tangled, divaricate branching and wide branching angles of *Samolus intricatus* (PERTH 08552185); B – the untangled, narrow-angled branching of *S.* sp. Millstream (M.I.H. Brooker 2076) (PERTH 07809689).

in deep, heavy, silty clays on the margins of salt lakes and saline floodplains, particularly at sites with seasonal freshwater inflows. Plants are also found adjacent to saline lake beds in *Melaleuca* shrublands on low, sandy rises, and in *Triodia* hummock grasslands. On Fortescue Marsh, it primarily grows in samphire shrublands in association with *Tecticornia indica* subsp. *bidens*, *T.* sp. Dennys Crossing (K.A. Shepherd & J. English KS 552), *T. globulifera*, *Muellerolimon salicorniaceum*, *Duma florulenta*, *Eremophila spongiocarpa*, *Melaleuca glomerata* and *M. xerophila*. It is also an important component of *Eucalyptus victrix*, *E. camaldulensis* and/or *Acacia ampliceps* dominated riparian vegetation on deep, water-logged clays fringing permanent to semi-permanent freshwater pools. Plants at Savory Creek were recorded in *Tecticornia* spp. samphire shrublands. In the Beyondie Lake – Lake Sunshine region, plants grow on small sandy rises adjacent to lake margins in association with shrublands of *Melaleuca interioris* and samphires of *Tecticornia bibenda*, *T.* sp. Dennys Crossing (K.A. Shepherd & J. English KS 552) and *T. indica* (Phoenix Environmental Pty Ltd 2018).

Conservation status. *Samolus intricatus* is currently listed as Priority One under the Conservation Codes for Western Australian Flora, under the name *Samolus* sp. Fortescue Marsh (*A. Markey & R. Coppen* FM 9702) (Western Australian Herbarium 1998-). It is found in the Fortescue Marsh Land System (Payne 2004), which itself is listed at the state level as a Priority Ecological Community (DBCA 2023, Markey 2017), and occurs in wetland habitats that are uncommon in the wider Pilbara and Little Sandy Desert regions. Current threats include trampling and browsing by cattle, and mining and exploration activities at Fortescue Marsh and in the Beyondie Lakes – Sunshine Lake region may impact populations through clearing, earthworks, roadworks or changes to surface water flows or groundwater levels and water quality.

Etymology. The specific epithet is from the Latin *intricatus* (entangled, intricate, and complex), which refers to the tangled, interlaced branching of the stems and inflorescences which leads to distinctively

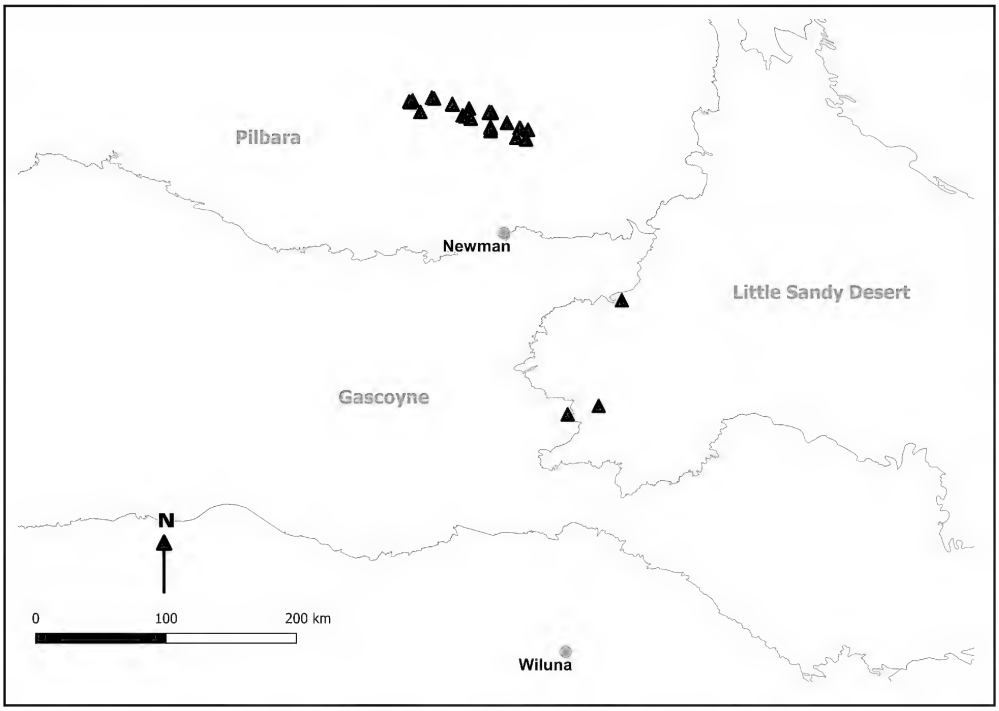

Figure 3. Known distribution of *Samolus intricatus* in the Pilbara, Little Sandy Desert and Gascoyne biogeographic regions in north-western Western Australian compiled from herbarium records held at the Western Australian Herbarium and from field observations made by the author at Fortescue Marsh. Biogeographic regions given are from version 7 of the Interim Biogeographic Regionalisation of Australia (IBRA7) (DCCEEW 2024).

flexible, springy, and densely divaricate plants that rebound back to their original form after being pushed (Figure 1).

Vernacular Name. A suggested vernacular name is Bouncing Brookweed, in reference to the distinctively elastic and pliable nature of the shrub.

Affinities. Based on its bracteate pedicels, erect habit and reduced cauline leaves, and referring to the molecular phylogenies presented by Wanntorp and Anderberg (2011), *S. intricatus* is assumed here to belong to a clade of mostly Australian taxa that includes phrase-named taxa or varieties of *S. repens* (J.R.Forst. & G.Forst.) Pers. *s. lat.* (*cf.* Bentham 1868), *S. eremaeus* S.W.L.Jacobs (from freshwater creeks in central Australia), *S. porosus* (L.f.) Thunb. (a South African species), *S. caespitosus* Keighery (from saline seasonal wetlands in southern Western Australia) and *S. junceus* R.Br. (from wetland and damp habitats in southern and western Western Australia) (Jacobs 1980; Wheeler 1987; Keighery 1988). The phylogenetic analysis of Wanntorp and Anderberg (2011) suggests that *S. repens* is paraphyletic, with the erect varieties being more genetically distant from the procumbent variety. This creeping, often coastal variety from southern Australia, Chile and Oceania is listed on the Western Australian Plant Census as *S. repens* (J.R.Forst. & G.Forst.) Pers. var. *repens* (synonym: *S. repens* var. *procumbens* R. Knuth (Pax & Knuth 1905)). *Samolus intricatus* is distinguished from *S. repens* var. *repens* by its erect, comparatively tall (> 30 cm) habit where robust stems with scale leaves arise from rhizomes to form rounded, tufted, clumps of shrubs, while the latter sends up leafy, wiry stems 2–40 cm in length and which range from prostrate to weakly ascending, resulting in plants that are sprawling, semi-prostrate herbs or form dense, spreading mats. The cauline leaves of *S. repens* var. *repens* are abundantly distributed along the stems and are distinctly green, fleshy and range from 1–2.5 cm in length. The staminodes of *S. repens* var. *repens* are distinctly longer than the stamens, whereas these are subequal to marginally shorter in *S. intricatus*. While

S. intricatus has a brown, scale-like bract located above the base to the middle of the pedicel, in *S. repens* var. *repens* this subtending bract is leaf-like, green and located at the base of the pedicel. Wanntorp and Anderberg (2011) interpreted this condition as being ebracteate in the procumbent variety.

Samolus intricatus appears to be most closely allied to a currently unresolved complex of four Western Australian taxa that all share a tall, erect, robust and clumped habit, the other taxa being *S.* sp. Millstream (M.I.H. Brooker 2076), *S.* sp. Shark Bay (M.E. Trudgen 7410), *S. repens* var. *floribundus* Benth. and *S. repens* var. *paucifolius* Benth. It is distinguished from these other four taxa by its dichotomously branched and interlaced racemes, stems and lateral branches, and having cauline leaves reduced to small, brown, scarious scales scattered sparingly along the stems. The other four taxa have relatively larger cauline leaves that are linear or linear-elliptic to linear-obovate, which are well-developed, fleshy and green, their stem branching is not divaricate nor tangled, the stem and panicle branching angles of the other taxa are smaller (< 50°), and the flowers have straight pedicels. The stems of *S. intricatus* and *S.* sp Millstream (M.I.H. Brooker 2076) share a similar range of widths (1.5–2.5(–3) mm) and flexibility, while the stems of the other three taxa can be wider (> 2.7 mm) and comparatively more rigid and stout. In the flowers of *S. intricatus* the corolla is always white and, unlike the other taxa, never pale pink when in bud or open, and the calyx lobes are more broadly triangular than for *S.* sp. Shark Bay (M.E. Trudgen 7410), *S. repens* var. *floribundus* and *S. repens* var. *paucifolius*. Calyx lobes of the latter two taxa can be up to twice the length of those in *S. intricatus*. *Samolus* sp. Millstream (M.I.H. Brooker 2076) is the most likely variant to be confused with *S. intricatus*, particularly by the similar flowers and small, decurved cauline leaves in the upper stems, but can be readily distinguished by narrow branching angles and a lack of divaricate branching in the stems, flowers with straight pedicels, and larger cauline leaves which remain green. Leaves in *Samolus* sp. Millstream (M.I.H. Brooker 2076) range from linear and short (1.5–3.5 mm) on the upper stems to linear-spathulate and 5–9 mm long on the lower stems. *Samolus intricatus* forms a dense, tangled, perennial bush that is generally free-standing but can grow through adjacent shrubs, whereas *S.* sp. Millstream (M.I.H. Brooker 2076) is an erect, untangled, free-standing shrub.

Like *S. intricatus*, *S. junceus* possesses cauline scale leaves sparsely scattered along stems > 30 cm long, but *S. junceus* differs by having unbranched to few-branched stems with a smaller branching angle and a rush-like, non-divaricate habit, the basal leaves are often persistent on mature plants, and flowering stems terminate in elongate, linear racemes or panicles from 5–27 cm long with flowers on straight pedicels subtended by a bract adnate to the base. Both *S. intricatus* and *S. eremaeus* have an erect habit exceeding 30 cm in height, but *S. eremaeus* is distinguished from *S. intricatus* by its broad, spathulate basal and cauline leaves which reach lengths of 11 cm and 5 cm respectively (Jacobs 1980).

Samolus intricatus shares a similar divaricate branching habit to the flowering stems of *S. caespitosus* but is distinguished from the latter species by having continuously replaced stems > 30 cm tall that arise from a woody, stout, horizontal rhizome, and single bracts subtending branches and pedicels. The longevity of individual stems of *S. intricatus* is unknown, but repeated observation has shown that shrubs will persist and grow over successive seasons if conditions are favourable. Conversely, *S. caespitosus* has an annual flowering stem that doesn't exceed 30 cm in height and arises from a persistent basal rosette of leaves, with each branch subtended by pairs of longer (up to 7 mm) bracts (Keighery 1988).

Notes. *Samolus intricatus* resides in semi-arid to arid wetland habitats that experience a range of extreme conditions, from flooding to severe drought, thermal stress and high salinity. Being a halophyte, excess salts are excreted through epidermal salt glands that appear as pores within raised bumps (Adam & Wiecek 1983) and that cover the stems, pedicels and calyces. Stems are the primary photosynthetic tissues and are produced from a robust hypogeogenous rhizome that is key to the plant's recovery after disturbance. Shrubs can tolerate periods of inundation in riparian and flood-prone habitats, and resprout readily after floodwaters subside. The entire shoot system can senesce during the extremely hot and dry conditions experienced on salt lake and floodplain margins, but vigorous new shoot growth recommences when cooler, wetter conditions return. Plants along permanent freshwater pools will remain green and actively growing throughout hot, dry periods.

The branching structure of the stems, raceme axis and pedicels can make interpretation of the inflorescence type difficult in *S. intricatus*. Racemes can appear as a corymbose raceme because of the upturned pedicels and twisting of the rachis, and groups of terminal racemes coming off the stems can make that section appear like an irregular panicle.

The *Nyiyaparli* name for *Samolus intricatus* is *Gurrungali*, and it was used to produce white smoke for signalling while mustering sheep around *Martuyitha* (*Karlka Nyiyaparli* Aboriginal Corporation 2023, Roy Hill Pty Ltd and *Karlka Nyiyaparli* Aboriginal Corporation 2021).

Identification. The key to Australian species of *Samolus* by Jacobs (1980), which was amended by Keighery (1988), is further modified here to include *S. intricatus* with a couplet that distinguishes it from *S. junceus*.

1. Mature plants with few or no leaves. If leaves present either these are normal sized and basal or very reduced and cauline..... **5**

1: Mature plants with basal and / or cauline leaves (at least on lower stems) well developed **2**

5. Stems unbranched or sparsely branched, straight and untangled, basal leaves present on mature plants, flowers on straight, slender pedicels, arranged on a long raceme with a linear rachis up to 27 cm in length, found in south-western Western Australia..... **S. junceus**

5: Stems divaricately branched and intricately tangled, basal leaves absent on mature plants, flowers on bent, upwardly reflexed pedicels, arranged on a short raceme with a non-linear rachis < 6 cm in length, found in semi-arid to arid zones in north-western Western Australia..... **S. intricatus**

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The *Nyiyaparli* and *Banjima* People are acknowledged as the Traditional Custodians of Fortescue Marsh (*Martuyitha / Manggurdu*), where fieldwork was undertaken, and the *Gingirana*, *Birriliburu* and *Martu* People are acknowledged as the Traditional Custodians of country that covers the eastern range of this species. Particular thanks are extended to Steven Dillon, Hamish Robertson and DBCA staff at Karijini National Park (Steve Berris, Dan Petersen, Ivan Thrash and Scott Godley) for logistical, field and herbarium support, and to Rebecca Coppen and Carolyn McCormick for field assistance. The Fortescue Marsh project was supported by Mike Lyons and Stephen van Leeuwen and funded as part of an offset package arrangement with Fortescue Metals Group Ltd and in partnership with DBCA (Ministerial Statement 707). I am grateful to current and previous staff at the Western Australian Herbarium for lodging accessions, and providing both records and access to the collections, including Skye Coffey, Julia Percy-Bower and Karina Knight. Terry Macfarlane and Greg Keighery are thanked for providing valuable input on inflorescence structure and *Samolus* taxonomy, respectively, and Terry Macfarlane and Timothy Utteridge for helpful comments on the manuscript.

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A new species of *Goodenia* (subg. *Porphyranthus* sect. *Ebracteolatae*) from arid Western Australia and the Northern Territory

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SHORT COMMUNICATION

The species of *Goodenia* described herein was recognised as distinct in the early 2000s by the lead author when it was found in a remote part of arid Northern Territory towards the Western Australian border. The phrase name *Goodenia* sp. Great Sandy Desert (D.E. Albrecht 10517) NT Herbarium was raised at that time, but the species was not formally described due to insufficient material. As the taxon was not known from further east, the collection location was suspected to be on the eastern edge of its distribution. A suite of specimens collected in arid Western Australia in 2017 and 2024, and subsequently lodged at the NT Herbarium, matched the original specimen of *G.* sp. Great Sandy Desert. Examination of specimens of morphologically similar species housed at PERTH by one of the authors (LWS) uncovered additional specimens of this morphologically and geographically cohesive new taxon. Amongst the PERTH material were two specimens seen by Roger Carolin in the early 1970s. Carolin's annotations on these specimens indicate that he considered them to be a distinct taxon, though his manuscript name ('*Goodenia deserti*') was never published, and it was not included in his *Flora of Australia* treatment of Goodeniaceae (Carolin 1992).

Methods and materials

The species description, which largely follows the format of Sage and Shepherd (2024), is based on specimens housed at PERTH and NT. Flowers were rehydrated prior to undertaking floral character observations and measurements. The length of fusion of the abaxial corolla lobes was measured from the sinuses between the abaxial lobes to the sinuses between the adaxial lobes and abaxial 'lip'. The seed images were taken with a Leica K3C microscope camera fitted to a Leica M80 stereomicroscope. A series of images were taken manually at different focal planes and combined into a single image using the focus stacking software Helicon Focus.

Taxonomy

Goodenia procumbens Albr., L.W.Sage & A.Schub., *sp. nov.*

Typus: WNW of Tjukurla, Western Australia [precise locality withheld for conservation reasons], 23 October 2017, *A. Schubert* 1162 (*holo*: NT D0276792; *iso*: PERTH 09692770).

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Goodenia sp. Great Sandy Desert (D.E. Albrecht 10517) NT Herbarium, Cowie, I.D. & Albrecht, D.E. in Cowie, I.D. & Albrecht, D.E. (eds) (2005), *Checklist of Northern Territory Vascular Plant Species* p. 26 Northern Territory Government, in *FloraNT*, https://eflora.nt.gov.au/ [accessed 11 November 2024]; Cuff, N.J., Albrecht, D.E., Elliot, L.P., Webb, A.T. & Cowie, I.D. (eds) (2024) *Checklist of the Vascular Plants of the Northern Territory 2024* p. 35, Northern Territory Government, in *FloraNT*, https://eflora.nt.gov.au/ [accessed 28 February 2025]; Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 30 November 2024].

Prostrate, procumbent or low spreading, multi-stemmed, perennial *herb* to *c.* 0.2 m high. *Stems* straight to slightly zig-zag, with an indumentum of stiff, spreading, straight to curved hairs 0.2–0.8 mm long and finer, weaker, often tangled hairs to *c.* 2.5 mm long, underlying tissue visible beneath indumentum, a dense tuft of white hairs in the leaf and bract axils. *Leaves* in a basal rosette and extending up the stems, occasionally fasciculate, narrowly oblanceolate, entire or occasionally with few, small, spreading, linear to narrowly triangular lobes 0.5–12 mm long, usually folded longitudinally or occasionally partially flattened, with a central vein or ridge; lamina 5–105 mm long, 0.5–3.1(–4) mm wide (excluding lobes if present), with an indumentum of stiff, ascending to spreading, straight to curved hairs 0.1–1 mm long and finer, weaker, often tangled hairs to *c.* 2 mm long on both surfaces and margins, underlying tissue visible beneath indumentum; apex rounded; base attenuate. *Flowers* arranged along main stems and lateral branches in terminal raceme-like cymes; bracts 4–41 mm long, indistinguishable from leaves, becoming smaller distally, entire; bracteoles absent; pedicels sigmoid, distally upturned or almost straight, 5–50 mm long, indumentum as for stems but additionally with minute, gland-tipped hairs *c.* 0.05 mm long, particularly distally; articulation line 1–1.5(–3) mm below the fruit, not prominent. *Sepals* free at or slightly below midway along the length of the fruit, equal or subequal, lanceolate to elliptic, 4–6.5 mm long, 0.9–1.6 mm wide, erect, with a moderately dense indumentum of minute, gland-tipped hairs *c.* 0.05 mm long and longer stiff, spreading to ascending, non-glandular hairs 0.2–1 mm long abaxially, with non-glandular hairs in distal half adaxially; apex acute. *Corolla* 10.5–18 mm long, predominantly yellow, brown/maroon at least in the proximal half of the adaxial lobes and brown/maroon flecked auricles, without enations, pouch evident but not pronounced, 2.1–3 mm long, 1.3–1.5 mm wide; outer surface with moderately dense gland-tipped hairs to *c.* 0.1 mm long and moderately dense longer, stiff, spreading to ascending, non-glandular hairs 0.2–1 mm long, inner surface with moderately dense short, spreading to descending, non-glandular hairs <0.1 mm long below midpoint, glabrous above; abaxial corolla lobes 3.5–4.5(–8.2) mm long, 1.4–2.5 mm wide, apex acute and slightly protruding, basally fused for a further 5.5–8 mm; wings 2–4.2(–6.5) mm long, 0.8–1.7 mm wide, ± entire, slightly undulate, subequal to or slightly exceeding the lobe; adaxial corolla lobes 6–11.2 mm long, 1.4–2 mm wide, apex acute and slightly protruding, basally fused for a further 2.5–4 mm; auricle 1.7–3.9 mm long, 2–2.7 mm wide, glabrous except for 0.1–0.2 mm long simple hairs along the inner margin; wing above auricle 3–6.3 mm long, 0.6–1.6 mm wide; wing opposite auricle 2–5.8 mm long, 0.7–1.7 mm wide. *Stamen* filaments linear, 2–3.5 mm long, 0.15–0.35 mm wide; anthers narrowly oblong to oblong-elliptic, 1.2–2 mm long, 0.5–0.9 mm wide. *Style* 4–5.5 mm long, 0.55–0.7 mm wide, with scattered, white hairs 0.5–0.7 mm long distally; indusium truncate depressed obovate to truncate transversely elliptic, 1.2–2.3 mm long, 2.2–2.8 mm wide, both surfaces with minute gland-tipped hairs and non-glandular hairs, both lips with dense, white bristles 0.1–0.5 mm long. *Ovary* with septum one-third to one-half as long as locules, with 15–31 ovules in 2 rows; septum with a few non-glandular hairs toward outer margins. *Fruit* globose to broadly ellipsoid, dorsiventrally compressed, 6–8(–9.5) mm long, 6–8 mm wide, with moderately dense gland-tipped hairs to 0.1 mm long and scattered stiff, spreading, non-glandular hairs to *c.* 1 mm long; valves opening at maturity. *Seed* body ovate, dark brown, 2.1–3 mm long, 1.5–2 mm wide, with numerous evenly distributed, small, acute projections; wing thin-textured, 0.8–2 mm wide, wider on one side, cream. (Figure 1)

Diagnostic features. *Goodenia procumbens* is a prostrate, procumbent or low spreading, multi-stemmed, perennial herb unique within subg. *Porphyranthus* sect. *Ebracteolatae* (K.Krause) K.A.Sheph. (Shepherd *et al.* 2020) by the following combination of characters: narrow, oblanceolate, entire or occasionally lobed leaves 0.5–3.1(–4) mm wide; all vegetative parts covered in an indumentum of stiff, ascending to spreading (spreading only on stems), straight to curved hairs and finer, weaker, often tangled hairs; sepals

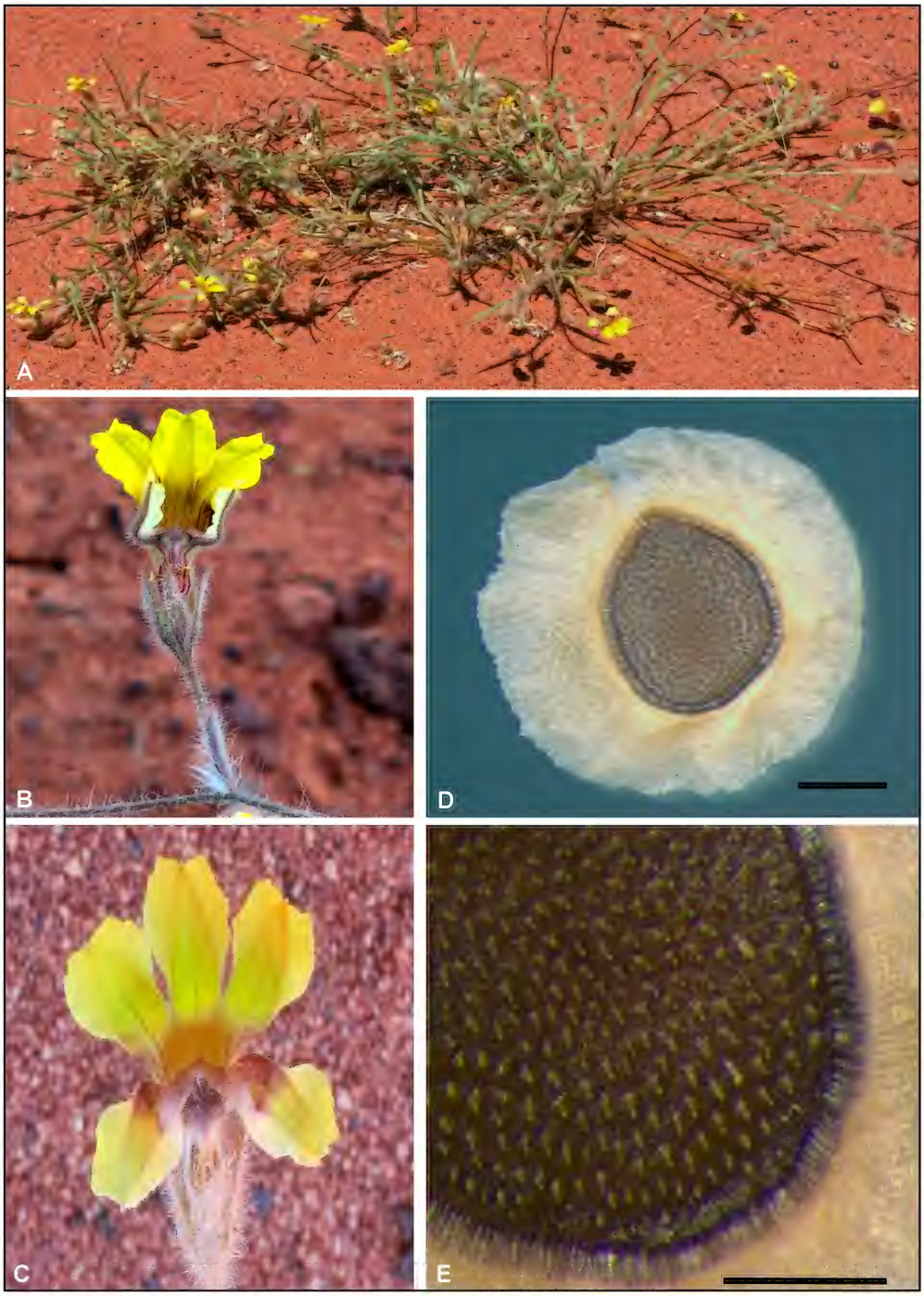

Figure 1. *Goodenia procumbens*. A – habit; B – section of inflorescence showing indumentum on axis, pedicel, sepals and external surface of corolla; note dense hairs in bract axil; C – flower showing the subequal width wings of the adaxial lobes with brown/maroon pigment on the proximal half; D – seed; E – magnified section of seed body showing numerous evenly distributed small acute projections. Scale bars: D = 1 mm; E = 0.5 mm. Vouchers *A. Schubert* 1160 (A, C), *A. Schubert* no voucher WA Ngururrpa IPA, 14.4 km SE of Lamanbundah (B), *D.E. Albrecht* 10517 (D, E). Photographs by Andrew Schubert (A–C), David Albrecht (D, E).

4–6.5 mm long; yellow corolla with some brown/maroon pigmentation, the outer surface with moderately dense, gland-tipped hairs to *c.* 0.1 mm long and moderately dense, longer, stiff, spreading to ascending, non-glandular hairs 0.2–1 mm long, and an inner surface with moderately dense short, spreading to descending, non-glandular hairs <0.1 mm long below midpoint and glabrous above; globose to broadly ellipsoid, dorsiventrally compressed fruits, 6–8(–9.5) mm long and 6–8 mm wide; and dark brown seeds 2.1–3 mm long and 1.5–2 mm wide, with numerous evenly distributed, small, acute projections and a thin-textured wing 0.8–2 mm wide.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Sep. 2015, *D.E. Albrecht* 14592, (CANB, PERTH); 20 July 2016, *T. Blake* DD 1271 (PERTH); 23 July 2016, *T. Blake* DD 1328 (PERTH); 8 July 1975, *B.C. Crisp* 342 (AD); 9 Sep. 2015, *R. Davis* 12658 (PERTH); 25 July 1967, *A.S. George* 8912 (PERTH, SYD); 28 July 1967, *A.S. George* 9042 (PERTH); 20 July 2016, *M. Goods* DD 999 (PERTH); 28 July 2016, *M. Goods* DD 1134 (PERTH); 5 Sep. 1998, *G.L. Liddelow* GD 9 (PERTH); 30 Apr. 2021, *J. Mitchell* LMJM-01 (PERTH); 30 Oct. 2017, *A. Schubert* 1160 (NT, PERTH); 25 Oct. 2017, *A. Schubert* 1161 (NT); 27 Oct. 2017, *A. Schubert* 1163 (NT); 19 July 2024, *A. Schubert* 1713 (NT); 19 July 2024, *A. Schubert* 1716 (NT); 19 July 2024, *A. Schubert* 1723 (NT); 5 Aug. 2016, *P. Trickett* DD 1472 (PERTH). NORTHERN TERRITORY: 17 Aug. 2003, *D.E. Albrecht* 10517 (AD, NT, PERTH).

Phenology. Flowering and fruiting specimens have been collected from July to October; however, it is likely to be reproductive at any time of the year if adequate soil moisture is available.

Distribution and habitat. *Goodenia procumbens* occurs in arid parts of Western Australia and the Northern Territory, mostly within about 150 km of the border separating the two jurisdictions. Most records are within the Great Sandy Desert bioregion (north and east of Kiwirrkurra, and north-west and south-east of Walangurru), with fewer records within the Central Ranges bioregion (north and north-west of Tjukurla). There is a solitary isolated record from west of Patjarr within the Gibson Desert bioregion (Figure 2). The general region is poorly surveyed, and additional populations are likely to be found with greater survey effort.

Most records are from sand plains and dune swales, with fewer records from plains or very gentle slopes with sandstone outcropping or lateritic gravel. There is a solitary record from an area with calcrete outcropping. Collections have typically been made in hummock grassland 0.5–3 years post-fire, sometimes with a sparse overstorey of *Allocasuarina decaisneana*, *Corymbia opaca*, *Eucalyptus pachyphylla*, *E. gamophylla* or *Acacia* spp. Commonly recorded associated species include *Triodia pungens*, *T. longiceps*, *Sida cardiophylla*, *Dicrastylis exsuccosa*, *Seringia exastia*, *Scaevola* spp. and *Ptilotus* spp.

Conservation status. Listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–). In Western Australia, the species is currently known from a small number of locations outside the conservation estate within an area that is under immediate threat from mining activities. In the Northern Territory, where it is known with certainty from only a single location, it is currently listed as Data Deficient (Northern Territory Herbarium 2015–). Further survey work in the region between the known population and the NT/WA border should be undertaken as a matter of priority.

Etymology. Named from the Latin *procumbens* (lying forward), in reference to the habit of the species.

Common name. Procumbent Goodenia.

Affinities. *Goodenia procumbens* is a member of subg. *Porphyranthus* sect. *Ebracteolatae* (Shepherd *et al.* 2020); however, in the absence of molecular data its affinities within that group remain uncertain. It has been confused with *G. microptera* F.Muell. and *G. armitiana* F.Muell., and is also superficially similar to *G. maideniana* W.Fitzg. and *G. virgata* Carolin.

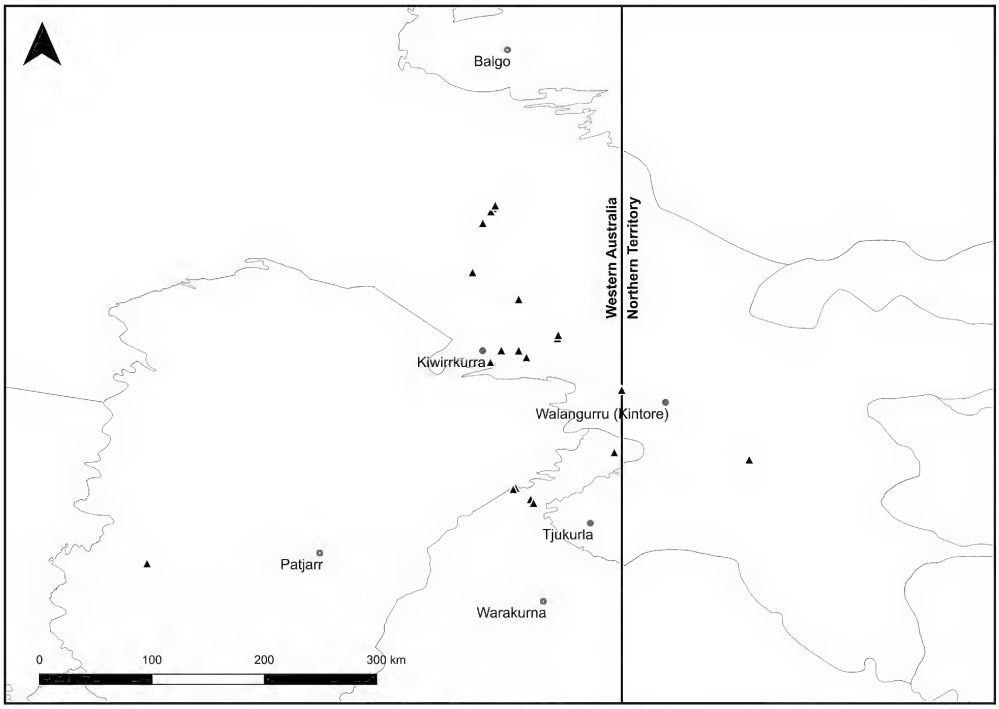

Figure 2. Distribution of *Goodenia procumbens* (▲) in arid parts of Western Australia and the Northern Territory near the border between the two jurisdictions, based on PERTH and NT specimens, with IBRA region boundaries (Australian Government Department of Agriculture, Water and the Environment 2012) in grey.

Goodenia microptera differs from *G. procumbens* in its erect to spreading habit (*cf.* prostrate, procumbent or low spreading), often broader lower leaves (1.7–12 mm wide *cf.* 0.5–3.1(–4) mm wide), the disparity in indumentum between vegetative and floral organs (i.e. basal leaf indumentum dominated by simple non-glandular hairs whilst indumentum of distal pedicels and flowers dominated by glandular-tipped hairs *cf.* non-glandular hairs forming the prominent hair type throughout though small glandular hairs present distally), shorter sepals (2–3 mm long *cf.* 4–6.5 mm long), the wing above the auricle on adaxial corolla lobe being consistently much narrower than the opposite wing (*cf.* wings ± similar), fewer ovules (6–12 *cf.* 15–31 ovules) and the reticulate seeds (*cf.* with numerous evenly distributed, small, acute projections). Also, the corolla usually has two patches of brown/maroon towards the margins of the abaxial lip, just below the outer two lobes. Based on current records *G. microptera* occurs no further east than *c.* 122.2 degrees longitude.

Goodenia armitiana differs from *G. procumbens* in its ascending to erect habit (*cf.* prostrate, procumbent or low spreading), usually partially varnished stems (*cf.* not varnished), consistently unlobed leaves (*cf.* at least some lobed leaves usually present), tightly conduplicate to involute linear bracts (*cf.* bracts longitudinally folded, narrowly oblanceolate), densely glandular hairy external corolla surface with no or sparse non-glandular hairs (*cf.* moderately dense gland-tipped hairs and non-glandular hairs), recurved abaxial corolla lobes (*cf.* not recurved), weakly developed wings on adaxial lobes (wing above auricle 1.4–4 mm long, 0.1–0.5(–1.1) mm wide *cf.* 3–6.3 long, 0.6–1.6 wide; wing opposite auricle 0.8–2.6 mm long, (0.1–)0.3–1.2 mm wide *cf.* 2–5.8 mm long, 0.7–1.7 mm wide), the wing above the auricle also being consistently much narrower than the opposite wing (*cf.* wings ± similar), and the generally greater distance between pedicel articulation and fruit base ((1.2–)1.5–4 mm) *cf.* 1–1.5(–3) mm). *Goodenia armitiana* occurs within the distribution range of *G. procumbens*.

Goodenia virgata superficially resembles *G. procumbens* but differs in its erect or occasionally spreading habit (*cf.* prostrate, procumbent or low spreading), glabrous vegetative parts (or with an occasional non-glandular hair <0.5 mm long *cf.* indumentum of non-glandular hairs), acute leaf apex (*cf.* rounded), shorter and narrower sepals 2.5–3.5 mm long, 0.5–0.8 mm wide (*cf.* 4–6.5 mm long, 0.9–1.6 mm wide), fewer ovules (6–12 *cf.* 15–31 ovules), colliculate seeds (*cf.* with numerous evenly distributed, small, acute projections) and the preference for saline habitats. *Goodenia virgata* occurs within the distribution range of *G. procumbens*.

Goodenia maideniana (and the closely related *G. anfracta* J.M.Black) superficially resemble *G. procumbens* but differ in having strigose hairs (i.e. appressed, straight) on vegetative parts, sepals and exterior of corolla (*cf.* hairs spreading to curved), the corolla lobe wings extending far beyond the tip of corolla lobes (*cf.* subequal to or slightly exceeding the lobe), the colliculate seeds (*cf.* with numerous evenly distributed, small, acute projections), and the preference for saline habitats. *Goodenia maideniana* occurs within the distribution range of *G. procumbens*.

Notes. Although most leaves are entire, at least some lobed leaves are present on the majority of specimens. There is some variation in the indumentum on vegetative parts, especially in the length of the shorter, rigid hairs and in the density of the longer, weaker hairs. Variation was also noted in the width of wings on the two adaxial corolla lobes, with the wing above the auricle being slightly narrower to subequal to the opposite wing. Although the majority of fruits were less than 8 mm long, a few were larger with a corresponding higher number of ovules.

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We thank Sally Mumford for preparing Figure 1, Steve Dillon and Kelly Shepherd for their helpful comments on the manuscript and Julia Percy Bower (PERTH), for prioritising the incorporation of NT duplicates of this species and the inclusion of the phrase name on the Western Australian vascular plant census to facilitate completion of the manuscript. We also acknowledge the traditional owners of Kiwirrkurra, Ngururrpa and Ngaanyatjarra for permission to access their country and collect specimens.

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Calandrinia sp. Boolardy Station (P. Jayasekara 719-JHR-01) is a synonym of *C. mirabilis* (Montiaceae)

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SHORT COMMUNICATION

Calandrinia mirabilis Chinnock & J.G.West was described by West and Chinnock (2013) as a large (5–15 cm tall, 10–120 cm diam.), prostrate to decumbent annual with fleshy, spathulate, basal leaves that become shorter and spathulate to obovate along each stem/scape, which usually terminates with an inflorescence axis of 3–7(–15) flowers. The flowers can be very large and showy (up to 45 mm diam.) and are medium pink to magenta in colour with irregular white, orange-red and yellow bands in the lower third, with 8–11 petals, 4 stigmas, and numerous stamens (e.g. *F. Obbens & R. Davis* FO 9/13 PERTH 08477361, https://www.inaturalist.org/observations/75628598). The capsules are 4-valved. Initially the valve tips barely separate (i.e. a pore-like opening); however, they may open further with maturity. Capsules appear square in cross section due to the valve abscission lines becoming slightly thickened and raised. Each capsule has many reniform to sub-reniform, shiny, mid to dark tan seeds, *c.* 0.6 mm long, 0.45 mm wide, with a very fine, colliculate, surface pattern.

Prior to being formally named, *C. mirabilis* was recognised at PERTH from 2009 by the phrase-name *C.* sp. Mt Clere (R.J. Dadd 5). At the time that name was erected, this taxon was known only from relatively few collections from Mt Clere, Walburg and Landor Stations in the mid to upper Gascoyne River catchment.

In October 2008 while undertaking a field survey for a proposed mining rail link to the Geraldton area, one of the consultant botanists (P. Jayasekara), collected a *Calandrinia* species on Boolardy Station, about 250 km east of Kalbarri in the Murchison bioregion. While this specimen had clear similarities to *C.* sp. Mt Clere it differed in regard to several characters such as: smaller spathulate basal leaves; smaller, lighter-coloured flowers with 8 petals only; a later flowering time; slightly smaller seeds, but with a very similar surface pattern; and capsules with 4, 5 and 6 valves on the same plant. In addition, the collecting locality was some 170 km south of the known distribution of *C.* sp. Mt Clere. I considered this entity to be either a new species or possibly a subspecies of *C.* sp. Mt Clere (i.e. what was later described as *C. mirabilis*). In an attempt to resolve this matter I returned to the original collection site on Boolardy Station in 2010 but failed to relocate the population and no new populations were discovered in the area. Further attempts in ensuing years to relocate *C.* sp. Mt Clere made no progress, but now the Station was under CSIRO control as the location of the Square Kilometre Array (SKA) project. The phrase-name *C.* sp. Boolardy Station (P Jayaeskara 719-JHR-01) hence was erected in 2017 to protect this entity from potential site works. In September 2024 a fieldtrip through a large part of Boolardy Station managed to locate several sizeable populations. Examination of those populations showed most plants have characters consistent with *C. mirabilis* and usually have 10 petals with occasional plants having fewer or more petals (8–12), and even fewer plants with variable valve numbers (>4). In respect to these characters, the original

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collected plant was aberrant and, therefore, I now consider that *C.* sp. Boolardy Station (P.Jayaeskara 719-JHR-01) should be synonymised under *C. mirabilis* and the following collections redetermined as such: *P. Jayasekara* 719-JHR-01 (PERTH); *B. Neasham* SKA-BN005 (PERTH); *F. Obbens* FO 01/24 (PERTH); *F. Obbens* FO 02/24 (PERTH).

Calandrinia mirabilis Chinnock & J.G.West, *J. Adelaide Bot. Gard.* 26: 97–101, figs 1–6, pl. 1 (2013).

Calandrinia sp. Mt Clere (R.J. Dadd 5), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 24 March 2025].

Calandrinia sp. Boolardy Station (P.Jayaeskara 719-JHR-01), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 24 March 2025].

Phenology. Flowering occurs from mid-September to mid-October dependent on the season and population location (i.e. northern populations may start flowering slightly earlier than southern populations). Seeds may remain on plants up to mid-November potentially.

Distribution and habitat. The original collections of *C. mirabilis* all come from a relatively small area of the mid Gascoyne region as previously stated, while the inclusion of the above specimens extends the distribution well southwards into Boolardy Station in the Murchison region. Another disjunct collection has also been found west of Wiluna (*J. Morrissey* 50) and was only determined as *C. mirabilis* in 2022 being among loan material returned from CANB. *Calandrinia mirabilis* prefers flats or small vegetated dunes with red to red-brown sandy clay or sometimes orange-brown sand. The predominant vegetation type is open *Acacia* shrubland (e.g. *A. ramulosa* var. *linophylla*, *A. incurvaneura*, *A. kempeana*, *A. rhodophloia*) and other shrubs including *Eremophila forrestii*, *Grevillea nematophylla*, *Hemigenia botryphylla*, *Ptilotus polystachyus*, *Senna artemisioides* subsp. *helmsii*, *Solanum lasiophyllum* and *Thryptomene decussata*. Grasses include *Aristida holathera*, *Eragrostis eriopoda* and *Eriachne mucronata* with a scattering of other annual species such as *Gnephosis tenuissima*, *Angianthus tomentosus* and *Calandrinia creethae*.

Conservation status. At present, *C. mirabilis* is listed as Priority One under Conservation Codes for Western Australia (Western Australian Herbarium 1998–). The addition of the Boolardy Station collections will change that status to Priority Three (Tanya Llorens pers. comm.), although finding more populations in the large area between the Gascoyne and Murchison regions is highly probable.

Affinities. *Calandrinia mirabilis* looks superficially similar to *C. papillata* Syeda, which is another 4-valved species with many petals (i.e. 7–9 petals), but is generally a smaller plant with mainly long, terete leaves and papillate seeds. Both these species belong within clade 6 (Hancock *et al.* 2018), which closely corresponds to section *Basales* (Von Poelnitz 1934); however, *C. mirabilis* is closest to *C. strophiolata* (F.Muell.) F.Muell. ex B.D.Jacks. within this current molecular phylogeny. *Calandrinia strophiolata* differs from *C. mirabilis* in having long, thin terete to compressed leaves rather than spathulate leaves; 6-valved rather than 4-valved capsules and very different seeds that are somewhat sub-reniform to tear-drop shaped, smooth and with a large and distinctive strophiole.

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Corrigendum to: *Stylidium* miscellany IV: novel species, recircumscriptions and range extensions for northern Australia

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SHORT COMMUNICATION

See *Nuytsia* 35: 141–198 (2024), https://doi.org/10.58828/nuy01072.

p. 171, Figure 14A. The voucher specimen for the seed of *Stylidium irriguum* should be corrected from *K. Coate* 372 to *K. Coate* 729.

p. 188. The phrase ‘stolen fragments and specimens’ should be amended to ‘fragments and specimens originating from other herbaria’. It was not our intention to cast aspersions on Allen Lowrie but to document the existence of type material in Herbarium Lowrieanum that had originated from BRI, K and PERTH. We unreservedly apologise for any distress that this has caused.

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The occurrence of *Convolvulus crispifolius* (Convolvulaceae) in Western Australia

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SHORT COMMUNICATION

The distribution of *Convolvulus crispifolius* F.Muell. is centred on eastern South Australia, the far north-west of Victoria and the far south-west of New South Wales, with a major outlying occurrence at the West Macdonnell Range, west of Alice Springs in the Northern Territory (*D.E Albrecht* 10320: BRI, NT). The species is not listed on Western Australia's vascular plant census, although a specimen collected from Norseman and housed at the State Herbarium of South Australia (*R. Bates* 24889: AD) was identified as this species in 2002 by Helmut Toelken. Two additional Western Australian specimens (*M. Lewis* 77/92, *R.J. Cranfield* 2563: PERTH), erroneously referred to the genus *Polymeria* R.Br. at the Western Australian Herbarium but with affinity to *C. crispifolius*, have recently come to my attention. Remarkably, both are from the Shark Bay area in the state's midwest region and would represent a significant range extension if confirmed as this species.

To confirm whether the species occurs in Western Australia, 16 specimens of *C. crispifolius*, including the Norseman collection, were loaned from the State Herbarium of South Australia. Both the Norseman and Shark Bay collections were found to be closely comparable in all respects to the loaned specimens of South Australian origin with the exception of the seeds, which are slightly smaller (to 2.5 mm long *cf.* mostly *c.* 3 mm long). Although noteworthy, the sample size is clearly too small to draw any taxonomic conclusions from this observation.

There is a degree of uncertainty as to whether the outlying populations in central Australia and Western Australia form part of the natural distribution of *C. crispifolius* or whether it has been introduced to these jurisdictions. Norseman is on the main road route between eastern and Western Australia and so it is conceivable that seed may have been caught up in the undercarriages or wheel arches of one of the very numerous heavy haulage vehicles that ply that route and transported over many hundreds of kilometres. An accidental introduction of this nature seems a less satisfactory explanation for its appearance in the West Macdonnell Range, although this population was recorded from within a hundred metres or so of a camping site (D. Albrecht pers. comm.), and is a rather improbable explanation for its occurrence in the Shark Bay area.

It is perhaps more likely that *C. crispifolius* has a wider natural distribution and is under-collected due to it being a disturbance opportunist. It has been noted as more common after fire in Victoria (Jeanes 1999) and the population in the West Macdonnell Range was collected from a recently burned site, with recent efforts to relocate plants unsuccessful (D. Albrecht pers. comm.). Plants with this biology have seeds with often complex dormancy factors and have the capacity to 'disappear' for extended periods of time between disturbance events (Baker *et al.* 2005). Indeed, the recently described *C. pyrophilus* O.Nazarova

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& Hislop from southern Western Australia (Nazarova & Hislop 2021) is an excellent example of this phenomenon. Ascertaining the native distribution of such species is inherently problematic without genomic comparison of populations across the species' range.

Convolvulus crispifolius F.Muell., *Linnaea* 25: 423 (1853), as *C. crispifolias* orth. var. *Type*: 'In montibus nudis petraeis aliquot milliaria Anglica directione boreali-orientali a Cudnaka' [South Australia], October 1851, *F. Mueller s.n.* (*syn*: MEL 1544962 image!, MEL 689518 image!, P 03543958 image!).

Specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 29 Sep. 1990, *R. Bates* 24889 (AD); 11 Nov. 1982, *R.J. Cranfield* 2563 (PERTH); 19 Dec. 1992, *M. Lewis* 77/92 (PERTH).

SOUTH AUSTRALIA: Lincoln Hwy, Hundred of Hawker, 16 km S of Elbow Hill, 25 July 1965, *C.R. Alcock* 652 (AD, BRI *n.v.*, PERTH); *c.* 9 km by road SE of Red Tank Dam, *c.* 13 km by road N of 3LO Dam, *c.* 41.5 km direct N of Hypurna HS, Danggali Conservation Park, 12 Sep. 1980, *W.R. Barker* 4323 (AD); 23 km NE of Poochera directly N of Karaultaby, 20 Oct. 1975, *R.J. Chinnock* 2915 (AD); Berri, Jan. 1921, *J.B. Cleland s.n.* (AD); Northern Yorke Peninsula, Hundred of Wiltunga, NW corner of section 168, 31 Aug. 1966, *B. Copley* 571 (AD, K *n.v.*); Eyre Peninsula, Gawler Ranges, Mt Ive, 28 Sep. 1969, *N.N. Donner* 3242 (AD, CANB *n.v.*); Murray District, between Overland corner and Barmera, 25 Sep. 1965, *Hj. Eichler s.n.* (AD); Lower Eyre Peninsula, boundary of reserve at junction of sections 24 & 14, Hundred of Verran, *c.* 95 km NNE of Port Lincoln, 23 Oct. 1963, *R.H. Kuchel* 1470 (AD); Eyre Peninsula, Carriewerloo Station, 500 m NW of Birthday Bank, 10 Oct. 1992, *D.J. Michael* 422 (AD); Hambidge Conservation Park, 30 Sep. 2000, *D.E. Murfet* 3783 (AD *n.v.*, PERTH); Murray [district], Cooltong Conservation Park, junction of main track and W fence, 13 Oct. 1993, *A.G. Spooner* 14529 (AD); Eyre Peninsula, on roadside of Swallows Nest Rd, 76 m W of junction with main Cowell–Whyalla Rd, *c.* 7 km from Cowell, 30 Mar. 2011, *R. Taylor* 1354 (AD, BRI *n.v.*); Eyre Peninsula, sand dunes on E part of Price Beach, 24 Oct. 1983, *H.R. Toelken* 7741 (AD, BRI *n.v.*).

Distribution and habitat. Eastern South Australia, north-western Victoria, south-western New South Wales and a single record from the Northern Territory. In Western Australia there is a record from Norseman and two from the Shark Bay area. The only habitat information associated with the Western Australian specimens is from *R.J. Cranfield* 2563: 'Occasional on degraded paddock. Brown sandy clay.' In his revision of the genus Johnson (2001: 17) gives the following description of its habitat preference elsewhere across the species' range: 'sandy and sandy-loam, sometimes rocky, soils, commonly in mallee scrubs and on sandhills'.

Conservation status. Although there remains some doubt whether the species is native to Western Australia, to take a precautionary approach the species is to be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.).

Typification. Johnson (2001: 15) cited MEL 1544962 as the holotype and MEL 689518 as an isotype; however, no holotype was designated by Mueller (1853) and, unlike the former, the latter bears his descriptive annotations. These specimens are therefore regarded as syntypes. P 03543958 is also considered a probable syntype despite being dated 1852, which is likely to be date the specimen was received at P.

Identification. Convolvulus crispifolius is a highly distinctive species on account of its dense, silvery indumentum and is unlikely to be confused with any other Western Australian species. It can be accommodated in Nazarova and Hislop's (2021) key to the Western Australian species by a modification to the second lead of couplet 1 and the addition of a new couplet, 1a:

1: Leaves on individual plants usually variously shaped, basal lobes often further divided into secondary lobes, sometimes the central lobes itself with secondary lobes, or margins undulate-crenate throughout

1a. Leaf margins undulate-crenate throughout; leaf surfaces completely obscured by a dense, appressed, silvery indumentum.....**C. crispifolius**

1a: All or at least some leaves deeply lobed, the individual lobes often further divided; leaf surfaces always readily discernible beneath a sparse to moderately dense indumentum **5**

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The concept of *Leucopogon* sp. Busselton (Ericaceae: Styphelioideae: Styphelieae) expanded to include *L.* sp. D Perth Flora

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SHORT COMMUNICATION

In the treatment of *Leucopogon* R.Br. for *Flora of the Perth Region*, Wheeler (1987) recognised two putatively undescribed taxa for the Swan Coastal Plain that she referred to by the informal names, '*L.* sp. B' and '*L.* sp. D. aff. polymorphus' (as *L.* sp. B Perth Flora (R.D. Royce 4360) and *L.* sp. D Perth Flora (aff. polymorphus) respectively on *Florabase*: Western Australian Herbarium 1998–). For many years afterwards, the application of these names was uncertain because, shortly after publication of the Flora, the relevant specimens formed part of an interstate loan. In the meantime, the phrase-name *L.* sp. Busselton (D. Cooper 243) was added to *Florabase* in March 2006 to accommodate a taxon from Group C (*sensu* Hislop & Chapman 2007; Hislop 2014) that occurs in wetlands from the Dardanup area to south-west of Busselton. When the loan material was returned in 2009 it was established that *L.* sp. Busselton matched Wheeler's concept of *L.* sp. B.

In her key to species, Wheeler (1987) distinguished *L.* sp. B from *L.* sp. D by the presence of petiolate leaves with narrowed bases (*cf.* sessile and not tapered in *L.* sp. D). The associated descriptions also indicated that *L.* sp. B had longer leaves (7–12 mm long *cf.* 3–5 mm) and a usually hairy ovary (*cf.* glabrous). In addition to the localities of Cannington and Mundijong in the Perth region, Wheeler recorded *L.* sp. D from Mt Barker and Donnybrook. The reference to Donnybrook is based on a collection by Cecil Andrews from August 1903 (PERTH 05700558); however, this specimen in every respect other than locality appears to be a duplicate of another Andrew's collection from Mundijong (PERTH 05700574). It seems very likely that the Donnybrook locality is an error as the *L.* sp. D morphotype has otherwise not been recorded from that area whereas there have been several subsequent collections from Mundijong. The Mt Barker occurrence was based on a collection by Col. Goadby from 1900 (PERTH 05700566), the identity of which is still not satisfactorily resolved. The taxonomy of Group C includes subgroups of considerable taxonomic complexity (Hislop 2014: 72–73) in which the circumscription of individual taxa is often very challenging. This is especially the case in the Stirling Range–Albany area where numerous collections with apparent affinity to *L. polymorphus* Sond., *L. assimilis* R.Br. and/or *L. cucullatus* R.Br. cannot at this stage be confidently assigned to any species. The Goadby collection is one such specimen.

While there are strong similarities between the *L.* sp. D morphotype and a number of collections from the Stirling Range–Albany area, subtle foliar differences, a different habitat preference, and a wide geographical disjunction suggest that they are unlikely to be conspecific. Relative to the *L.* sp. D morphotype, plants from the Stirling Range–Albany area can usually be distinguished by their leaves having a sub-glaucous aspect, a more pronounced mid-rib abaxially and/or distinct grooves on either side of the midrib. Furthermore, they are plants of dry rather than wetland habitats. With the removal of Mt Barker and Donnybrook from its putative distribution it has become clear that, like *L.* sp. Busselton, the *L.* sp. D morphotype is a plant restricted to winter-wet habitats on the Swan Coastal Plain.

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Leucopogon sp. D was removed from Western Australia's plant census in 1995, with specimens treated under a broad circumscription of *L. polymorphus*. In retrospect, this decision was less than satisfactory because the *L.* sp. D morphotype is consistently distinguishable from *L. polymorphus* by its glabrous or sometimes slightly scabrous, un-grooved to very shallowly grooved abaxial leaf surfaces and wetland habitat (*cf.* usually distinctly hairy, deeply grooved leaves and dry habitat preference for *L. polymorphus*). The status of the *L.* sp. D morphotype has remained unresolved until now.

Since the publication of *Flora of the Perth Region*, numerous additional collections from wetlands on the Swan Coastal Plain have become available for study at PERTH. These have had the effect of shrinking the putative morphological differences between *L.* sp. Busselton and the *L.* sp. D morphotype to a point where it now seems reasonable to treat the two as representing variation within a single species. Similarly, the apparent geographical disjunction between the Perth region and the Busselton–Dardanup area has been filled to a significant degree by collections from near North Dandalup (*F. Hort* 1831) and west of Yarloop (*A. Webb* AW 09043). Although there is a tendency for southern populations (i.e. those referred to *L.* sp. Busselton in its original sense) to have longer leaves than those in the Perth region (the *L.* sp. D morphotype) there is now no disjunction evident in leaf length, and while the latter always has more or less sessile, broad-based leaves, this feature is variable in the southern populations with some having clearly petiolate leaves (*D. Cooper* 243) and others quite sessile (*G.J. Keighery* 8286). A similar situation applies to ovarian hairs: southern populations may have either hairy or glabrous ovaries while only glabrous ovaries have been recorded further north. Furthermore, there is no correlation evident in the southern populations between the presence of a petiole and ovarian hairs, for example both *D. Cooper* 243 and *G.J. Keighery* 8286 have hairy ovaries.

While the morphological evidence for combining the *L.* sp. D morphotype with *L.* sp. Busselton now appears strong, formally circumscribing a species derived from such a combination without resolving the status of the various morphotypes in the Stirling Range–Albany area would be premature. It would also be necessary to consider a morphologically similar but unplaced entity that occurs in dry habitats in the Wannamal area of the northern Darling Range (e.g. *M. Hislop* 4455). Ideally, a focussed molecular study of Group C should be a part of future studies in Western Australian *Leucopogon*. This would help to resolve some of the many taxonomic difficulties in the group resulting from the frequently complex patterns of morphological variation.

Prior to the expanded circumscription adopted here, *L.* sp. Busselton had been assessed as Priority Two under Conservation Codes for Western Australian Flora. The inclusion of the northern populations significantly expands the distribution of this taxon, with several of these occurring in nature reserves, and it has therefore been downgraded to Priority Three (Western Australian Herbarium 1998–). Its preferred wetland habitat is particularly vulnerable both to the ongoing effects of climate change and to significant weed incursions.

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Clarification of *Amanita umbrinella* (Agaricales: Amanitaceae: *Amanita* sect. *Amarrendiae*) and three new, related agaricoid species from Australia

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Abstract

Davison, E.M., Giustiniano, D. & Catcheside, P.S. Clarification of *Amanita umbrinella* (Agaricales: Amanitaceae: *Amanita* sect. *Amarrendiae*) and three new, related agaricoid species from Australia. *Nuytsia* 36: 19–51 (2025). *Amanita umbrinella* E.-J.Gilbert & Cleland is re-described based on the lectotype and collections from around Australia; *Amanita umbrinelloides* A.E.Wood is synonymised with it. Additional information is provided for *A. muriniflammea* Tulloss, A.M.Young & A.E.Wood. Three closely related species are described herein as: *Amanita horizontalis* E.M.Davison & Giustiniano, *Amanita doreta* E.M.Davison & Giustiniano, and *Amanita cinereoalba* E.M.Davison, Giustiniano & P.S.Catches. *Amanita horizontalis* differs from *A. umbrinella* in its taller habit, in having a membranous partial veil that is horizontal when young, ellipsoid to elongate spores, and in molecular sequences. It occurs in South Australia, Tasmania, Victoria and Western Australia. *Amanita doreta* is similar in appearance to *A. horizontalis* and has similar shaped spores; but it differs in molecular sequences and occurs in Western Australia. *Amanita cinereoalba* is a grey, small to medium sized species with a descendent, evanescent partial veil, and large, broadly ellipsoid to ellipsoid spores. It differs in molecular sequences and occurs in South Australia. The 28S gene region indicates *A. cinereoalba* is closely related to the sequestrate species *A. grandis* (Bougher) Justo and *A. oleosa* (Bougher & T.Lebel) Justo.

Introduction

Species of the genus *Amanita* Pers. are some of the commonest and most recognisable mushrooms in the Australian bush. However, species delimitation is challenging, requiring a combination of macroscopic, microscopic and molecular characters to provide robust descriptions of known species and species new to science.

Amanita is a large and cosmopolitan genus, with more than 1440 names (Tulloss & Yang 2025). Most species are agaricoid, whilst a few are sequestrate. The species are ecologically important because most are believed to be mycorrhizal with woody plants. They are economically important because some are traditional foods for indigenous people, some have medicinal properties, whilst others are extremely poisonous (Cai *et al.* 2014; Wu *et al.* 2019). The genus is defined by the presence of a membranous or friable universal veil, the microscopic characters of bilateral lamella trama and acrophysalidic stipe trama, and the ontogenetic character of schizohymenial development (Bas 1969).

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In Australia the genus has been monographed by Reid (1980) and Wood (1997). Additional, recent descriptions and clarifications have been made by Miller (1991, 1992), Miller and Horak (1992), Tulloss *et al.* (1995), Grgurinovic (1997), Bougher (1999), Bougher and Lebel (2002), Justo *et al.* (2010), Davison (2011), Davison and Giustiniano (2020, 2023), Davison *et al.* (2013, 2015, 2017a, 2017b, 2020, 2021, 2023) and McGurk *et al.* (2016). Approximately 100 Australian species have been formally named, but many more await description.

The recent revision of *Amanita* by Cui *et al.* (2018) using a multi-molecular marker dataset has clarified relationships within this large genus. They recognised three subgenera: *Amanita*, *Amanitina* (E.-J.Gilbert) E.-J.Gilbert, and *Lepidella* Beauseigneur, which can be separated by spore amyloidy and mycorrhizal or saprotrophic habit. In subgenus *Amanita*, basidiospores are inamyloid and the species are believed to be mycorrhizal with woody plants. Cui *et al.* (2018) recognised four sections within this subgenus: *Amanita*, *Amarrendiae* (Bougher & Lebel) Zhu L.Yang, Y.Y.Cui, Q.Cai & L.P.Tang, *Caesareae* Singer, and *Vaginatae* (Fr.) Quél. Members of sections *Caesareae* and *Vaginatae* have a membranous universal veil which remains as a saccate volva at the base of the stipe and differ by the presence (sect. *Caesareae*) or absence (sect. *Vaginatae*) of a partial veil, and are cosmopolitan. Members of sect. *Amanita* are agaricoid, the universal veil on the pileus remains as warts, patches or powder, and there is usually a bulb at the base of the stipe; they are widespread. Members of sect. *Amarrendiae* are either agaricoid or sequestrate, the basidiospores are either smooth or ornamented, and clamp connections are present; the base of the stipe of agaricoid species is hardly inflated; sequestrate species are either stipitate or astipitate. Sect. *Amarrendiae* appears to be Gondwanan, having been recorded only in South America, New Zealand and Australia.

Cui *et al.* (2018) recognised two agaricoid members of sect. *Amarrendiae* in Australia: *A. muriniflammea* Tulloss, A.M.Young & A.E.Wood and *A. umbrinella* E.-J.Gilbert & Cleland. Based on their morphological similarity, it is likely that the following species with inamyloid spores are also in this section: *A. bambra* Grgur., *A. conicogrisea* A.E.Wood and *A. umbrinelloides* A.E.Wood, even though clamp connections were not seen in *A. bambra* and *A. conicogrisea* (Grgurinovic 1997; Wood 1997).

Amanita umbrinella is reported as widespread in Australia, occurring in the Australian Capital Territory (ACT), New South Wales (NSW), Queensland (Qld), Tasmania (Tas), South Australia (SA), Victoria (Vic) and Western Australia (WA) (Atlas of Living Australia 2023). A detailed macroscopic and microscopic description of *A. umbrinella* from WA was given in Bougher and Syme (1998). However, examination of collections identified as *A. umbrinella* from the southwest of WA has shown that there are two species of somewhat similar macroscopic appearance, which differ in spore size and shape, and molecular sequence.

The holotype of *A. umbrinella* was collected from Milson Island, Hawksbury River, NSW, in 1913. It was originally identified as the northern hemisphere species *Amanita pantherina* (DC.) Krombh. (Cleland & Cheel 1914). The collection was of two basidiomes and was illustrated with a water colour painting (Figures 1, 2 in Cleland and Cheel (1914), reproduced in this paper as Figures 3A, B). According to Tulloss (2025), Cleland sent a group of collections with similar macroscopic appearance, together with field notes, photographs, sketches and water colour paintings, to the French mycologist E.-J. Gilbert. Gilbert separated collections with inamyloid spores and described them as *A. umbrinella*; the collection illustrated by the water colour painting in Cleland and Cheel (1914) was designated as the 'type' (Gilbert 1941a, b). The location of the type was unknown for many years, and Tulloss (2025) suggested it was retained by Gilbert and lost with his herbarium. However, the type of *A. umbrinella* (AD-C3103) has been recently located. It shows the spores are inamyloid, subglobose to broadly ellipsoid, and that there are clamp connections at the base of the basidia. These observations, together with its macroscopic appearance, have formed the basis of our concept of *A. umbrinella*.

The aims of this paper are firstly to confirm the placement of *A. umbrinella* and related agaricoid species in sect. *Amarrendiae*. To do this we have used the nuclear ribosomal large subunit rRNA (28S) region because this is the only region available from GenBank for all type species of sections within subgenus *Amanita*. We have also used the other gene regions used by Cui *et al.* (2018) (β-tubulin, translation elongation factor 1-alpha (*tef1-α*) and RNA polymerase II (*rpb2*)) to examine the relationships between

agaricoid and sequestrate species within sect. *Amarrendiae*. We have used morphology and multi-marker data sets to examine collections of *A. umbrinella* from Australian herbaria to determine whether more than one species is present, and re-describe *A. umbrinella* using modern techniques. Lastly, we have assessed the variation between clones of the nuclear ribosomal internal transcribed spacer region (ITS) of the collections, because our past work has shown considerable clonal variation in Australian species from subgenus *Amanitina* (Davison *et al.* 2020, 2021, 2023).

Methods

Collections examined. Herbarium codes follow Index Herbariorum (https://sweetgum.nybg.org/science/ih/, accessed 17 February 2025), and the private herbaria of R.E. Tulloss and A.M. Young are abbreviated as RET and YOUNG, respectively. Collections of *A. bambra, A. conicogrisea, A. muriniflammea, A. umbrinella* and *A. umbrinelloides* were examined from AD, BRI, CANB, HO, MEL, PERTH and UNSW (Table 1). The spores were measured and mounted in Melzer's reagent to determine whether they were inamyloid. Any collections that had amyloid spores, or which were immature, were identified as *Amanita* sp. and not progressed further. Collections from UNSW were difficult to work with; they were brittle, had very few mature spores and basidia, and usable DNA was extracted from only one collection.

Taxonomy. The methodology for describing the macroscopic and microscopic characters largely follows Tulloss (2000). Colour names, for the colour of spores in deposit and other shades of white to cream (designated by the letters A–G), follow Royal Botanic Garden Edinburgh (1969), whilst other colour codes are from Kornerup and Wanscher (1983). In the descriptions of basidiospores (and basidia) the notation [x/y/z] denotes x basidiospores measured from y basidiomes from z collections. Biometric variables for spores follow Tulloss (2000), specimen = basidiome, i.e. '**L** = the average spore length computed for one specimen examined, **L′** = the average spore length computed for all spores measured, **W** = the average spore width computed for one specimen examined, **W′** = the average spore width computed for all spores measured, Q = the ratio of length/width for one spore, **Q** = the average value of Q computed for all spores of one specimen examined, **Q′** = the average value of Q computed for all spores measured'. Tulloss (2000) also notes that spores 'should always be measured in lateral view with apiculus and both ends of the spore all in focus. When presenting a range of measurements of the form (*a*–)*b*–*c*(–*d*), the numbers have the following meanings: *a* = the smallest value encountered, *b* = the greatest measured value such that at least 95% of all spores measured yielded a number greater than or equal to *b*, *c* = the least measured value such that at least 95% of all spores measured yielded a number less than or equal to *c*, *d* = the largest value measured'.

Author citations follow Index Fungorum (https://www.indexfungorum.org/names/names.asp [accessed 19 February 2025]). Descriptions are from collections for which at least one molecular sequence is available.

Phylogenetics. DNA extraction, amplification and cloning of the ITS and amplification of the β-tubulin, 28S, *tef1-α* and *rpb2* gene regions for all collections with inamyloid spores (apart from the holotypes, because this is not allowed under the loan agreements) follow the methodology of Davison *et al.* (2013, 2017b). PCR product was sent for dual direction sequencing using the commercial services of Australian Genome Research Facility (Perth node), using Big Dye® Terminator v3.1 Cycle Sequencing Kit in accordance with ABI protocols (Applied Biosystems, Foster City, California, USA).

The forward and reverse sequences were assembled with Geneious (version 12.2.6, https://www.geneious.com/; Kearse *et al.* 2012) using the Geneious Alignment option (settings set to automatically determine sequence direction, cost matrix 65% similarity, gap open penalty 12, gap extension penalty 3) to generate a single consensus sequence.

Additional 28S sequences from subgenus *Amanita* that were used for placement of *A. umbrinella* and the new species within a section, together with ITS, β-tubulin, *tef1-α* and *rpb2* gene regions from named species from sect. *Amarrendiae*, were accessed from GenBank (see https://www.ncbi.nlm.nih.gov/ [accessed 7 July 2024]) (Tables 2, 3).

Table 1. Voucher information for collections used in this study. DNA extraction was attempted from all listed collections from AD, AQ, CANB, HO, MEL, PERTH and UNSW which had inamyloid spores, apart from the types. Character columns are: Spores, whether spores were inamyloid (Y) or not (N) or immature (?); Q, average value of Q (the ratio of length/width for one spore) computed for all spores of one basidiome examined; Clamp, for whether clamp connections were seen (Y) or not (N); and DNA, for whether sequences were successfully generated (Y) or not (N) or types (N/A). Abbreviations are: CP, conservation park; NP, national park; SF, state forest; ACT, Australian Capital Territory; NSW, New South Wales; Qld, Queensland; Tas, Tasmania; SA, South Australia; Vic, Victoria; WA, Western Australia.

Name on specimen	Number	Date	Locality	Spores	Q	Clamp	DNA	Revised name
A. pantherina	AD-C3103	14.4.1913	Milson Island, NSW	Y	1.17, 1.24	Y	N/A	*A. umbrinella* type
A. umbrinella	AD-C49441	2.7.2002	Lincoln NP, Eyre Peninsula, SA	Y	1.40	Y	N	*Amanita* sp.
A. umbrinella	AD-C49442	2.7.2002	Lincoln NP, Eyre Peninsula, SA	Y	1.54	Y	Y	*A.* aff. *horizontalis*
A. aff. *umbrinella*	AD-C52855	14.7.2005	Deep Creek CP, SA	N	1.30			*Amanita* sp.
A. umbrinelloides	AD-C53026	14.8.2006	Mambray Creek, Mt Remarkable NP, SA	Y	1.48	Y	Y	*A. cinereoalba*
A.? umbrinella	AD-C53045	16.8.2005	Mambray Creek, Mt Remarkable NP, SA	Y	1.50	Y	Y	*A. cinereoalba*
A. umbrinella	AD-C54952	31.5.2006	Porter Scrub CP, Lobethal, SA	Y	1.22	Y	Y	*A. muriniflammea*
A. umbrinella	AD-C55036	19.7.2005	Flinders Chase NP, SA	Y	1.75	Y	Y	*A. horizontalis*
A. umbrinella	AD-C55038	26.9.2005	Mount Bold Reservoir Reserve, SA	Y	1.28	Y	N	*Amanita* sp.
A. umbrinelloides	AD-C56186	30.5.2009	Kaiserstuhl CP, SA	Y	1.12	Y	Y	*A. umbrinella*
A. grisella (inamyloid spores)	AD-C56413	9.4.2004	Cox Scrub CP, Mt Compass, SA	Y	1.20	Y	Y	*A. umbrinella*
A. umbrinella	AD-C56630	10.5.2005	Mt George CP, SA	Y	1.19	Y	Y	*A. muriniflammea*
A. bambra	AD-C58001	31.5.2012	Marshes Forest Reserve, SA	Y	1.06	N	N	*A. cheelii*
A. umbrinelloides	AD-C58328	29.6.2013	Engelbrook Reserve, Bridgewater, SA	N	1.10	N		*A.* cf. *luteofusca*
A. umbrinelloides	AD-C60063	20.7.2016	Mambray Creek, Mt Remarkable NP, SA	Y	1.39	Y	Y	*A. cinereoalba* type
A. murinoflammea type	BRI AQ 642698	5.1.1991	Blackbutt, Qld	Y	1.39	Y	N/A	*A. muriniflammea*
A. murinoflammea	BRI AQ 794056	23.3.2010	Girraween NP, Qld	?				*Amanita* sp.
A. murinoflammea	BRI AQ 794060	23.3.2010	Girraween NP, Qld	Y	1.42	Y	Y	*A. roseolamellata*
A. murinoflammea	BRI AQ 794062	23.3.2010	Girraween NP, Qld	Y	1.25	Y	Y	*A. umbrinella*
A. murinoflammea	BRI AQ 877087	11.4.2015	Girraween NP, Qld	N	1.44			*Amanita* sp.
A. umbrinella	CANB 574479.1	2.11.1992	Black Mountain Reserve, ACT	Y	1.09	Y	N	*Amanita* sp.
A. bambra	CANB 629135.1	8.11.1999	Weddin Mountains NP, ACT	Y	1.13	Y	N	*Amanita* sp.
A. umbrinella	CANB 574478.1	1.2.1995	Black Mountain Reserve, ACT	Y	1.16	Y	Y	*A. muriniflammea*
A. umbrinella	HO 559528	7.12.2010	Fern Tree, Tas	Y	1.40	Y	Y	*A. horizontalis*
A. umbrinella	HO 590308	30.12.2008	Gowrie Park, Tas	Y	1.24	Y	N	*Amanita* sp.
A. umbrinella	MEL 2069117	22.5.1981	Gembrook, Vic	N	1.13			*Amanita* sp.
A. umbrinella	MEL 2086675	31.7.2000	Royal Botanic Gardens, Cranbourne, Vic	N	1.12			*Amanita* sp.
A. umbrinella	MEL 2314568	18.4.1978	Eastern Highlands, Vic	Y	1.42	Y	Y	*A. horizontalis*

Name on specimen	Number	Date	Locality	Spores	Q	Clamp	DNA	Revised name
A. umbrinella	MEL 2314569	20.4.1982	Sherbrooke Forest, Vic	N	1.48			*Amanita* sp.
A. umbrinella	MEL 2366595	20.11.2007	Mersey SF, Tas	N	1.37			*Amanita* sp.
A. umbrinella	MEL 2371735	6.6.2007	Great Otway NP, Vic	Y	1.25	Y	N	*Amanita* sp.
A. umbrinella	MEL 2371914	31.8.2013	Baluk Willam Flora Reserve, Vic	N	1.38			*Amanita* sp.
A. umbrinella	MEL 2385791	24.5.2015	Valley Reserve, Mount Waverley, Vic	N	1.18			*Amanita* sp.
A. umbrinella	MEL 2432442	4.8.2018	Cobram, Vic	Y	1.35	Y	Y	*A.* aff. *horizontalis*
A. umbrinella	PERTH 09577211	16.6.2013	Shire of Mundaring, WA	Y	1.66	Y	Y	*A. horizontalis*
A. umbrinella	PERTH 09576916	1.6.2019	Shire of Waroona, WA	Y	1.32	Y	Y	*A. horizontalis*
A. umbrinella	PERTH 09577157	24.4.2016	Shire of Serpentine-Jarrahdale, WA	Y	1.25	Y	Y	*A. umbrinella*
A. umbrinella	PERTH 09577122	3.6.2013	Shire of Manjimup, WA	Y	1.30	Y	Y	*A. umbrinella*
A. umbrinella	PERTH 09576983	6.6.2010	Shire of Dandaragan, WA	Y	1.28	Y	Y	*A. umbrinella*
A. umbrinella	PERTH 08093229	27.6.2007	City of Gosnells, WA	Y	1.45	Y	Y	*A. horizontalis*
A. umbrinella	PERTH 09577254	2.6.2013	Shire of Manjimup, WA	Y	1.52	Y	Y	*A. horizontalis* type
A. umbrinella	PERTH 09577203	11.6.2006	City of Melville, WA	Y	1.52	Y	Y	*A. horizontalis*
A. umbrinella	PERTH 09578811	16.5.2016	Shire of Cuballing, WA	Y	1.55	Y	Y	*A. doreta*
A. umbrinella	PERTH 09703357	13.6.2018	Shire of Augusta-Margaret River, WA	Y	1.75	Y	Y	*A. doreta* type
A. conicogrisea type	UNSW DB16612	8.5.1985	Royal NP, NSW	Y	1.06	N	N/A	*A. conicogrisea* type
A. umbrinella	UNSW DB22934	17.3.1983	Mooball SF, NSW	Y	1.14	N	N	*Amanita* sp.
A. umbrinella	UNSW DB22935	9.4.1983	Cumberland SF, NSW	Y	1.35	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22944	16.4.1989	Chichester SF, NSW	Y	1.48	N	N	*Amanita* sp.
A. umbrinelloides	UNSW DB22947	4.5.1983	Castlereagh SF, NSW	Y	1.24	Y	N	*Amanita* sp.
A. umbrinelloides	UNSW DB22949	28.3.1992	Dharug NP, NSW	Y	1.12, 1.17, 1.21	Y	N	*Amanita* sp.
A. umbrinelloides type	UNSW DB16622	13.6.1985	Watagan SF, NSW	Y	1.15, 1.18	Y	N/A	*A. umbrinella*
A. umbrinella	UNSW DB22936	14.4.1983	Newnes Plateau, NSW	Y	1.52	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22937	14.4.1983	Newnes Plateau, NSW	Y	1.36	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22938	7.5.1985	Mount Druitt, NSW	Y	1.29	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22940	22.5.1986	Howes Valley, NSW			Y	Y	*A. umbrinella*
A. umbrinella	UNSW DB22941	28.3.1987	Mt Wilson, NSW	Y	1.25	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22942	30.4.1988	Jenolan Caves, NSW	Y		Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22943	16.4.1989	Chichester SF, NSW	Y	1.51	Y	N	*Amanita* sp.
A. umbrinella	UNSW DB22945	5.5.1990	Tidbinbilla NR, ACT	Y	1.18, 1.20	Y	N	*Amanita* sp.

Name on specimen	Number	Date	Locality	Spores	Q	Clamp	DNA	Revised name
A. umbrinelloides	UNSW DB22946	4.5.1983	Berkshire Park, NSW	Y	1.19	Y	N	*Amanita* sp.
A. umbrinelloides	UNSW DB22948	4.5.1983	Berkshire Park, NSW	Y	1.18, 1.23	Y	N	*Amanita* sp.

Table 2. Voucher information and GenBank accession numbers for nuclear ribosomal large sub-unit rRNA (28S) sequences from types of sections and other relevant collections used to place new species in subgenus *Amanita*. Newly published sequences are shown in bold. Abbreviations are: CP, conservation park; NP, national park; ACT, Australian Capital Territory; NSW, New South Wales; Qld, Queensland; Tas, Tasmania; SA, South Australia; Vic, Victoria; WA, Western Australia; 28S, nuclear ribosomal large sub-unit rRNA.

Section	Amanita species	Number	Location	28S
Amanita	*A. muscaria*	HKAS61888	Heilongjiang, China	MH486651
	A. diemii	MES1335	Neuquen, Argentina	KY053387
	A. fibrillopes	PERTH 08793573	Shire of Cuballing, WA	MN918099
	A. subglobosa	HKAS58837	China	JN941152
Amarrendiae	*A. oleosa*	PERTH 07552238	Australia	GQ925377
	A. arenaria	B2081	Australia	MK278596
	A. grandis	PERTH 07571852	Australia	GQ925376
	A. inculta	PERTH 07571704	Australia	GQ925371
	A. inculta	PERTH 08474028	Australia	MK278597
	A. inculta	PERTH 09472703	Shire of Jerramungup, WA	**PQ459801**
	A. merxmuelleri	CT4216	Tierra del Fuego, Argentina	KY053388
	A. morenoi	MES1588	Los Rios, Chile	KY053383
	A. morenoi	MES1301	Rio Negro, Argentina	KY053382
	A. morenoi	MES1774	Los Rios, Chile	KY053386
	A. morenoi	MES1616	Los Rios, Chile	KY053384
	A. morenoi	MES1624	Los Rios, Chile	KY053385
	A. muriniflammea	NY 66697	ACT	HQ539711
	A. muriniflammea	AD-C54952	Porter Scrub CP, SA	**PQ459794**
	A. nigrescens	JAC12804	New Zealand	MT862262
	A. nouhrae	MES1126	Rio Negro, Argentina	KY053389
	A. nouhrae	MES1921	Rio Negro, Argentina	KY053391
	A. pseudoinculta	PERTH 08474028	Australia	MH486771
	A. pseudoinculta	PERTH 08105731	Stirling Range NP, WA	**PQ459799**
	A. pseudoinculta	PERTH 08105731	Australia	MH486770
	A. pseudoinculta	PERTH 08073392	WA	KY053392
	A. pseudoinculta	VPI 366	Australia	GQ925372
	A. pseudoinculta	VPI 411	Australia	GQ925373
	A. pseudoinculta	VPI 558	Australia	GQ925374
	A. pseudoinculta	VPI 555	Australia	GQ925375
	A. sp. 'albertellarum'	RET 562-9	Lithgow, NSW	KX270335
	A. umbrinella	AD-C56413	Cox Scrub CP, SA	HQ539857
	A. umbrinella	PERTH 09576983	Shire of Dandaragan, WA	**PQ459787**
	A. umbrinella	PERTH 09577122	Shire of Manjimup, WA	**PQ459792**

Section	Amanita species	Number	Location	28S
	A. umbrinella	PERTH 09577157	Shire of Serpentine-Jarrahdale, WA	**PQ459786**
	A. umbrinella	AD-C56186	Kaiserstuhl CP, SA	**PQ459795**
	A. umbrinella	AD-C56413	Cox Scrub CP, SA	**PQ459796**
	A. umbrinella	BRI AQ 794062	Girraween NP, Qld	**PQ459800**
Caesareae	*A. caesarea*	HKAS96166	Italy	MH486418
	A. torrendii	HKAS59739	Spain	KU714555
	A. roseolamellata	BRI AQ 794060	Girraween NP, Qld	**PQ459798**
	A. roseolamellata	B2229	Australia	MK277561
Vaginatae	*A. vaginata*	KA12-0962	South Korea	KF021689
	A. albidostipes	HKAS57358	Yunnan, China	MH486756
	A. changtuia	HKAS92100	Heilongjiang, China	MH486442
Phalloideae	*A. phalloides*	HKAS75773	China	JX998060
	A. eucalypti	PERTH 08809828	Australia	KY977707
	A. cinereoalba	AD-C60063	Mt Remarkable NP, SA	**PQ459797**
	A. doreta	PERTH 09578811	Shire of Cuballing, WA	**PQ459788**
	A. doreta	PERTH 09703357	Shire of Augusta-Margaret River, WA	**PQ459789**
	A. horizontalis	HO 559528	Fern Tree, Tas	**PQ459785**
	A. horizontalis	PERTH 09577254	Shire of Manjimup, WA	**PQ459791**
	A. horizontalis	PERTH 09577203	City of Melville, WA	**PQ469924**
	A. aff. *horizontalis*	MEL 2432442	Cobram, Vic	**PQ459790**
	A. aff. *horizontalis*	AD-C49442	Lincoln NP, SA	**PQ459793**

Table 3. Voucher information and GenBank accession numbers for some species from sect. *Amarrendiae*. Newly published sequences are shown in bold. Abbreviations are: ITS, nuclear ribosomal transcribed spacer region; *tef1-α*, translation elongation factor 1-alpha; *rpb2*, RNA polymerase II; β-tubulin, β-tubulin region; ACT, Australian Capital Territory; NSW, New South Wales; Qld, Queensland; Tas, Tasmania; SA, South Australia; Vic, Victoria; WA, Western Australia.

Amanita species	Number	Location	ITS	tef1-α	rpb2	β-tubulin
A. cinereoalba	AD-C53026	Mambray Creek, Mt Remarkable NP, SA	**PQ457001–PQ457003**			
A. cinereoalba	AD-C53045	Mambray Creek, Mt Remarkable NP, SA	**PQ456995–PQ457000**			
A. cinereoalba type	AD-C60063	Mambray Creek, Mt Remarkable NP, SA	**PQ457015–PQ457019**	**PQ610510**	**PQ493147**	
A. doreta	PERTH 09578811	Shire of Cuballing, WA	**PQ457004–PQ457008**	**PQ610511**	**PQ493146**	
A. doreta type	PERTH 09703357	Shire of Augusta-Margaret River, WA	**PQ457009–PQ457014**	**PQ610512**	**PQ493145**	**PQ610506**
A. horizontalis	AD-C55036	Flinders Chase NP, SA	**PQ454004–PQ454008**		**PQ493148**	
A. horizontalis	HO 559528	Fern Tree, Tas	**PQ456155–PQ456158**	**PQ610526**	**PQ493152**	
A. horizontalis	MEL 2314568	Eastern Highlands, Vic	**PQ456163–PQ456166**			
A. horizontalis	PERTH 09577203	City of Melville, WA	**PQ456150–PQ456154**	**PQ610528**	**PQ493151**	
A. horizontalis	PERTH 09577211	Shire of Mundaring, WA	**PQ453998–PQ454003**			
A. horizontalis	PERTH 09576916	Shire of Waroona, WA	**PQ456167–PQ456172**			
A. horizontalis	PERTH 08093229	City of Gosnells, WA	**PQ456173–PQ456176**	**PQ610527**	**PQ493150**	
A. horizontalis type	PERTH 09577254	Shire of Manjimup, WA	**PQ453990–PQ453997**	**PQ628076**	**PQ493149**	

Amanita species	Number	Location	ITS	tef1-α	rpb2	β-tubulin
A. aff. *horizontalis*	AD-C49442	Lincoln NP, Eyre Peninsula, SA	**PQ456992–PQ456994**	**PQ610525**	**PQ493153**	**PQ610505**
A. aff. *horizontalis*	MEL 2432442	Cobram, Vic	**PQ456988–PQ456991**	**PQ610524**	**PQ493154**	**PQ610504**
A. inculta	PERTH 09472703	Shire of Jerramungup, WA	**PQ457074-PQ457077**	**PQ610513**	**PQ493144**	
A. muriniflammea	AD-C54952	Porter Scrub CP, Lobethal, SA	**PQ456159–PQ456162**	**PQ610514**	**PQ493156**	
A. muriniflammea	AD-C56630	Mt George CP, SA	**PQ456146**	PQ610515		**PQ610508**
A. muriniflammea	CANB 574478.1	Black Mountain Reserve, ACT	**PQ456147–PQ456149**	**PQ610516**	**PQ493155**	
A. nigrescens	JAC12804	New Zealand			MT993770.1	MT993792.1
A. pseudoinculta	PERTH 08105731	Shire of Cranbrook	**PQ457020-PQ457024**		**PQ493143**	
A. pseudoinculta	PERTH 08474028	Australia		MH508998.1		
A. pseudoinculta	PERTH 08105731	Australia		MH508997.1 **PQ610517**		
A. umbrinella	No voucher	NSW	AY194981			
A. umbrinella	AD-C56186	Kaiserstuhl CP, SA	**PQ416778–PQ416782**	**PQ610521**	**PQ493141**	**PQ610507**
A. umbrinella	AD-C56413	Cox Scrub CP, SA	**PQ416787–PQ416791**	**PQ610522**	**PQ493142**	
A. umbrinella	BRI AQ 0794062	Girraween NP, Qld	**PQ415184–PQ415187**	**PQ610523**		**PQ610509**
A. umbrinella	PERTH 09577157	Shire of Serpentine-Jarrahdale, WA	**PQ415188–PQ415191**	**PQ610518**	**PQ493139**	
A. umbrinella	PERTH 09577122	Shire of Manjimup, WA	**PQ415197–PQ415200, PQ433167–PQ433170**	**PQ610520**	**PQ493140**	
A. umbrinella	PERTH 09576983	Shire of Dandaragan, WA	**PQ415192–PQ415196**	**PQ610519**		
A. umbrinella	UNSW DB22940	Howes Valley, NSW	**PQ416783–PQ416786**			
A. eucalypti (outgroup)	PERTH 8809828	Australia		MF000751.1	MF000758.1	MF000746.1

Maximum likelihood phylogenetic trees were built using MEGA version 5.05 (Tamura *et al.* 2011) following alignment with MUSCLE (Edgar 2004). The best model for each dataset was selected using the Model Function, which indicated that the Kimura 2-parameter model (Kimura 1980) with a gamma distribution of rate variation across sites was best for all five alignments (28S, *tef1-α*, *rpb2*, β-tubulin, and concatenation of 28S, *tef1-α* and *rpb2*).

The differences between cloned haplotypes of the ITS region were obtained from the Distance Matrix: % Identity of an alignment in Geneious and presented as contingency tables (Tables 4–8).

Results

The analysis of the 28S region for all type species of all sections within subgenus *Amanita* together with additional species (Table 2) shows *A. umbrinella*, *A. muriniflammea*, *A. horizontalis sp. nov.*, *A. doreta sp. nov.* and *A. cinereoalba sp. nov.* clustered within sect. *Amarrendiae* (Figure 1). *Amanita umbrinella* is in a well supported clade (bootstrap (BS) 93), as are *A. muriniflammea* (BS 99), *A. horizontalis* (BS 99) and *A. doreta* (BS 99). *Amanita cinereoalba* clusters with the two secotioid species *A. grandis* and *A. oleosa* in a well-supported clade (BS 98); it is separate from the New Zealand species *A. nigrescens* and the South American species *A. merxmuelleri*, *A. morenoi* and *A. nouhrae*. The NSW agaricoid species *A.* sp. 'albertellarum' falls within sect. *Amarrendiae* but does not cluster with any of the other agaricoid species.

Additional gene regions (*tef1-α, rpb2* and β-tubulin) are available for some collections within sect. *Amarrendiae* (Table 3). Phylogenetic analysis of the *tef1-α* gene region (Figure 2A) shows *A. cinereoalba*

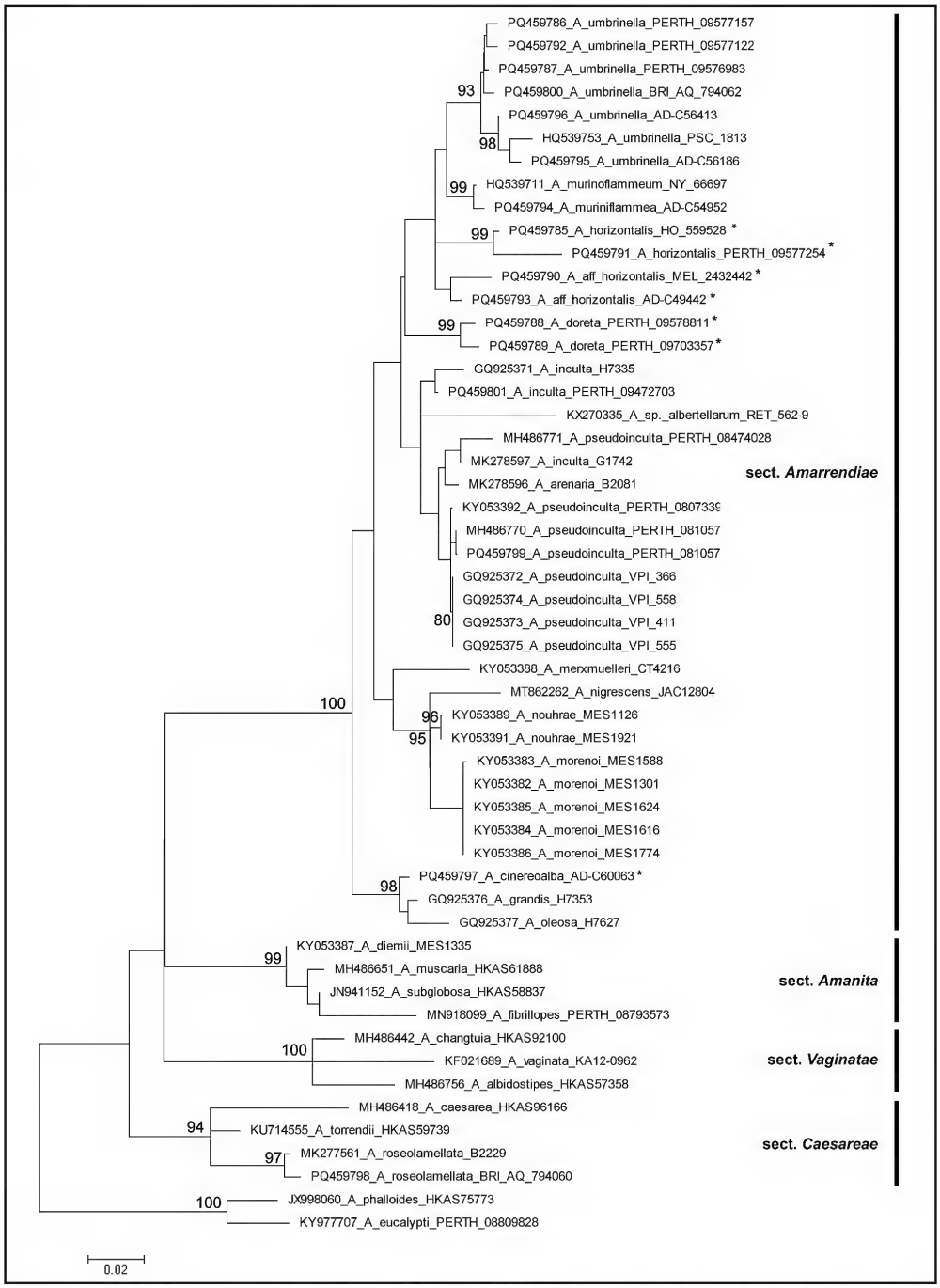

Figure 1. Molecular phylogenetic analysis by the maximum likelihood method of 28S (nuclear ribosomal large sub-unit rRNA) sequences (591 base pair positions), showing the position of *Amanita cinereoalba, A. doreta*, *A. horizontalis*, and *A.* aff. *horizontalis* within subgen. *Amanita.* The tree is rooted on *A. phalloides* and *A. eucalypti* (subgen. *Amanitina* sect. *Phalloideae*). Each section is listed on the right and the new species are indicated by *. Branches corresponding to partitions reproduced in less than 50% of the bootstrap replicates are collapsed. The tree is drawn to scale with branch lengths measured in the number of substitutions per site. Maximum likelihood bootstrap values greater than 80% are shown on the branches.

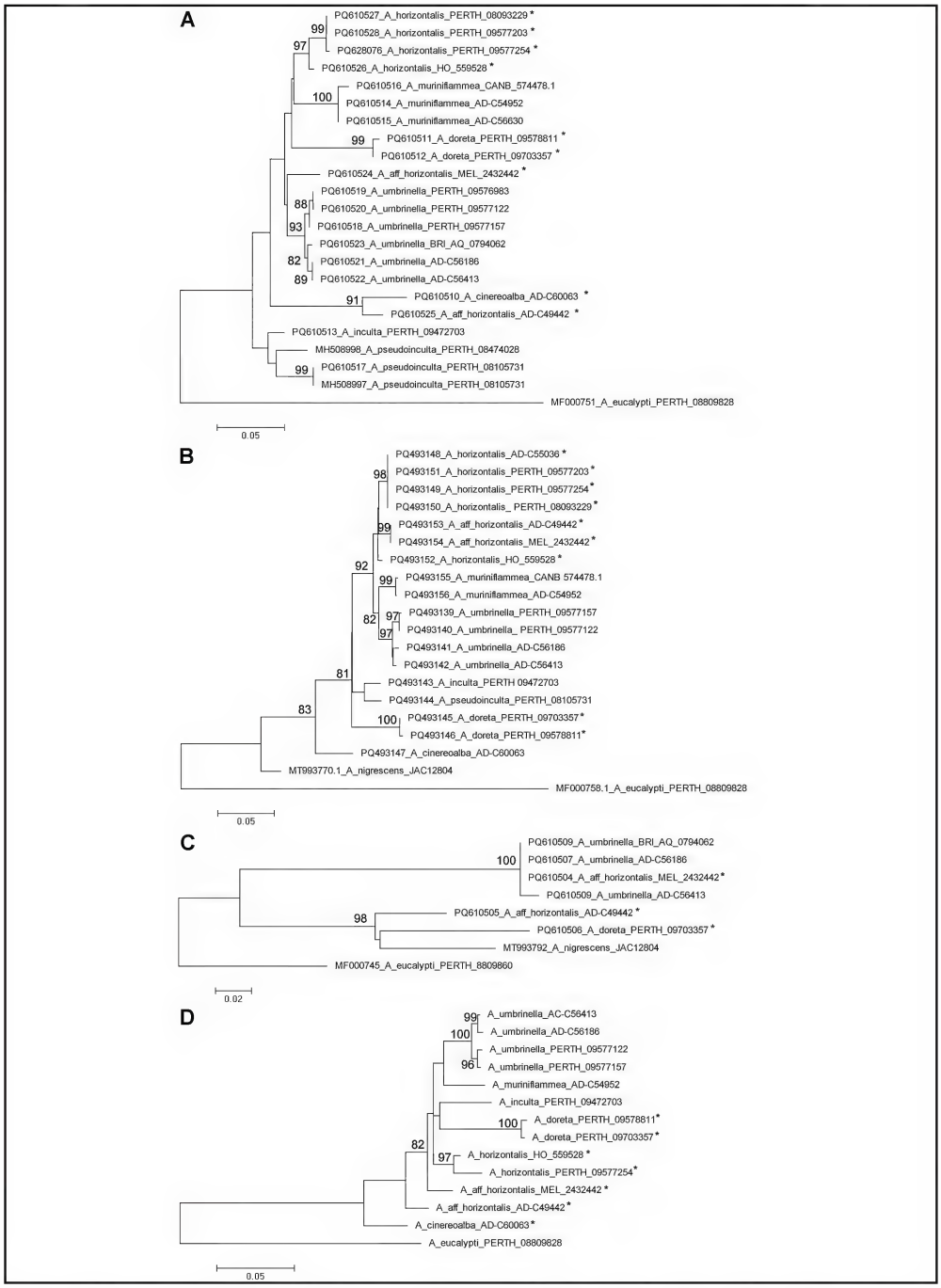

Figure 2. Molecular phylogenetic analysis by the maximum likelihood method for three regions and a concatenated alignment of three regions for species of *Amanita*. A – *tef1-α* (translation elongation factor 1-alpha, 475 base pair positions); B – *rpb2* (RNA polymerase II, 654 base pair positions); C – β-tubulin (342 base pair positions); D – concatenated 28S, *tef1-α* and *rpb2* (1709 base pair positions). All trees are rooted on *A. eucalypti* (subgen. *Amanitina* sect. *Phalloideae*). New species are indicated by *. Branches corresponding to partitions reproduced in less than 50% of the bootstrap replicates are collapsed. The tree is drawn to scale with branch lengths measured in the number of substitutions per site. Maximum likelihood bootstrap values greater than 80% are shown on the branches.

clusters with a collection identified as *A.* aff. *horizontalis* (AD-C49442) with good support (BS 91), both collections of *A. doreta* cluster together with good support (BS 99), four collections of *A. horizontalis* cluster together with good support (BS 97), three collections of *A. muriniflammea* cluster together with good support (BS 100), six collections of *A. umbrinella* cluster together with good support (BS 93), and one collection identified as *A.* aff. *horizontalis* (MEL 2432442) clusters with *A. umbrinella* but with poor support. Phylogenetic analysis of the *rpb2* gene region (Figure 2B) shows that there is a clade with good support (BS 92) which contains the agaricoid species *A. umbrinella*, *A. muriniflammea*, *A. horizontalis* and material identified as *A.* aff. *horizontalis*. The two collections of *A. doreta* cluster together (BS 100). *Amanita cinereoalba* does not cluster with the other agaricoid species. Phylogenetic analysis of the β-tubulin gene region (Figure 2C) shows two well supported clades, the first (BS 100) comprises three collections of *A. umbrinella* along with *A.* aff. *horizontalis* MEL 2432442, whilst the other clade (BS 98) comprises *A. doreta*, *A.* aff. *horizontalis* AD-C49442, and the New Zealand species *A. nigrescens*. Phylogenetic analysis of concatenated 28S, *tef1-α* and *rpb2* sequences (Figure 2D) recovers a clade of four *A. umbrinella* collections for which these gene regions are available with good support (BS 100); this clade is sister to a single collection *A. muriniflammea* but with poor support. Two *A. doreta* collections form a clade with good support (BS 100), sister (with poor support) to the single collection of *A. inculta*. The two collections of *A. horizontalis* cluster together with good support (BS 97).

A comparison of cloned haplotypes of the ITS region from *A. cinereoalba*, *A. doreta*, *A. horizontalis*, *A. muriniflammea* and *A. umbrinella* showed that there was up to 10.0% variation between haplotypes from the same sample, and up to 16.8% variation between haplotypes from the same species (Tables 4–8). There was 13.1–26.6% variation between haplotypes from different species (Tables 4–8).

Table 4. Percentage difference between ITS clones from collections of *A. umbrinella*, and in comparison to *A. muriniflammea*, *A. horizontalis*, *A. doreta* and *A. cinereoalba*. GenBank ITS sequence numbers are given in Table 3. The ITS region is 541–560 base pairs long. Column 'Cl.' is the number of clones or sequences.

Name / Number	Cl.	No voucher (AY194981)	AD-C56186	AD-C56413	BRI AQ 0794062	PERTH 09576983	PERTH 09577122	PERTH 09577157	UNSW DB22940
A. umbrinella / No voucher (AY194981)	1	N/A							
AD-C56186	5	13.3–14.8	0.2–5.6						
AD-C56413	5	14.6–16.9	4.6–10.6	0.9–7.7					
BRI AQ 0794062	4	13.1–15.0	7.5–11.2	10.0–13.4	0.4–5.6				
PERTH 09576983	5	13.6–13.9	9.1–11.8	11.5–12.8	7.4–11.3	2.2–7.3			
PERTH 09577122	8	13.7–14.6	7.7–10.2	10.5–12.8	7.8–10.9	5.1–10.0	0.5–5.4		
PERTH 09577157	5	12.6–13.0	6.6–9.1	9.5–10.7	5.2–8.6	3.4–7.8	3.8–7.1	0.0–4.0	
UNSW DB22940	4	13.0–14.3	4.3–8.2	6.2–11.1	8.3–11.9	9.1–11.9	6.9–10.2	6.4–9.4	1.8–4.9
A. muriniflammea / AD-C54952	4	8.9–11.2	12.9–16.1	14.9–17.4	13.3–17.0	13.9–16.0	14.5–16.4	13.1–14.4	13.1–16.2
A. horizontalis type / PERTH 09577254	8	15.1–16.8	17.9–20.5	19.3–22.5	17.0–19.8	17.4–19.9	16.9–19.7	15.9–18.4	16.9–20.2
A. doreta type / PERTH 09703357	6	19.1–20.3	19.7–22.0	21.5–23.8	19.3–21.5	20.6–22.5	20.5–22.4	19.8–21.1	20.4–22.1
A. cinereoalba type / AD-C60063	5	22.3–24.2	23.4–25.4	24.2–26.8	22.5–24.6	22.2–25.0	23.0–25.2	21.5–23.6	22.1–25.1

Table 5. Percentage difference between ITS clones from collections of *A. muriniflammea* and in comparison to *A. horizontalis*, *A. doreta* and *A. cinereoalba*. GenBank ITS sequence numbers are given in Table 3. The ITS region is 535–550 base pairs long. Column 'Cl.' is the number of clones or sequences.

Name / Number	Cl.	AD-C54952	AD-C56630	CANB 574478.1
A. muriniflammea / AD-C54952	4	2.7–4.7		
AD-C56630	1	4.9–6.7	N/A	

Name / Number	Cl.	AD-C54952	AD-C56630	CANB 574478.1
CANB 574478.1	3	5.7–8.4	3.3–5.5	3.9–4.9
A. horizontalis type / PERTH 09577254	8	15.0–18.0	16.3–17.5	17.1–19.1
A. doreta type / PERTH 09703357	6	20.0–22.3	20.1–20.5	20.8–21.9
A. cinereoalba type / AD-C60063	5	22.1–25.1	23.0–25.9	22.8–23.8

Table 6. Percentage difference between ITS clones from collections of *A. horizontalis* and *A.* aff. *horizontalis* and in comparison to *A. doreta* and *A. cinereoalba*. GenBank ITS sequence numbers are given in Table 3. The ITS region is 536–555 base pairs long. Column 'Cl.' is the number of clones or sequences.

Name / Number	Cl.	AD-C55036	HO 559528	MEL 2314568	PERTH 08093229	PERTH 09576916	PERTH 09577203	PERTH 09577211	PERTH 09577254	AD-C49442	MEL 2432442
A. horizontalis / AD-C55036	5	0.2–4.7									
HO 559528	5	10.7–13.7	0.0–2.4								
MEL 2314568	4	4.7–7.8	10.2–12.3	0.2–0.7							
PERTH 08093229	4	6.4–11.2	10.5–15.1	2.5–8.0	0.4–7.2						
PERTH 09576916	6	7.0–10.5	11.1–14.2	5.7–8.1	4.7–10.2	0.2–7.6					
PERTH 09577203	5	8.3–12.9	12.6–16.8	7.9–10.5	8.6–11.4	4.5–11.2	0.9–10.0				
PERTH 09577211	6	6.8–10.7	9.7–13.5	5.6–8.2	5.5–8.9	2.7–8.7	6.5–10.5	0.0–4.9			
PERTH 09577254 type	8	8.6–11.1	11.7–15.4	3.6–8.2	3.1–9.3	4.5–9.3	5.8–11.2	3.8–9.1	0.7–7.4		
A. aff. *horizontalis* / AD-C49442	6	25.2–25.8	22.6–24.1	25.6–26.3	25.7–27.3	25.1–26.6	26.4–27.4	23.9–25.4	25.6–26.8	0.0–4.5	
MEL 2432442	4	16.8–19.0	13.5–15.1	16.3–17.7	17.0–20.0	16.5–19.3	18.0–20.5	14.4–17.9	17.4–19.3	24.3–25.7	3.2-5.3
A. doreta type / PERTH 09703357	6	21.3–22.9	18.2–20.8	21.2–23.5	21.6–23.7	22.3–23.7	22.6–24.7	20.5–22.4	21.2–24.4	20.4–22.1	22.3–23.8
A. cinereoalba type / AD-C60063	5	24.2–25.7	21.9–24.1	24.3–25.8	23.6–26.8	23.9–26.7	24.7–27.5	23.1–24.8	24.1–26.4	22.1–25.1	23.7–24.8

Table 7. Percentage difference between ITS clones from collectons of *A. doreta* and in comparison to *A. cinereoalba*. GenBank ITS sequence numbers are given in Table 3. The ITS region is 544–562 base pairs long. Column 'Cl.' is the number of clones or sequences.

Name / Number	Cl.	PERTH 09578811	PERTH 09703357
A. doreta / PERTH 09578811	5	0.5–8.0	
PERTH 09703357 type	6	8.7–14.0	0.4–2.8
A. cinereoalba type / AD-C60063	5	23.4–26.1	25.2–26.6

Table 8. Percentage difference between ITS clones from collections of *A. cinereoalba*. GenBank ITS sequence numbers are given in Table 3. The ITS region is 531–547 base pairs long. Column 'Cl.' is the number of clones or sequences.

Name / Number	Cl.	AD-C53026	AD-C53045	AD-C60063 type
A. cinereoalba / AD-C53026	3	1.1–6.9		
AD-C53045	6	9.8–14.6	0.2–8.3	
AD-C60063 type	5	12.3–15.2	12.3–14.9	0.9–6.3

Taxonomy

Amanita umbrinella E.-J.Gilbert & Cleland, in Bresadola, *Iconogr. Mycol.* (Milan), Suppl. 1, 27(2): 273 (1941) [MB284081]; *Amanitaria umbrinella* E.-J. Gilbert & Cleland, in Bresadola, *Iconogr. Mycol.* (Milan), Suppl. 1, 27(1): 77 (1940) [MB284095], *nom. inval.*, Art. 38.1, as '*A. umbrinella* (Gilbert et Cleland) nob.: t. 23 et 24'. *Type citation*: 'Cleland, J. B. et Cheel, E. (The Agricultural Gazette New South Wales. 1914, XXV: 887, t. 1, f. 1-2, *Amanita pantherina.* - Aquarelle n. 5. - Photographie n. 40, *Amanita grisea.* - Herbier: n. 22, collection type (aquarelle n. 5), 3; n. 14, collection syntype (photographie n. 40), 4, sporée; n. 15, 17, 19, 21, 24, 26 (dessin à la plume n. 42), collections typiques; n. 16, 18, 25)! … Ar. distr.: Australia, New South Wales, South Australia. *Loc. orig.* New South Wales, Milson Island, Hawkesbury River.' *Type specimen*: Milson Island, Hawkesbury River, New South Wales, 14 April 1913, *J.B. Cleland s.n.* (*lecto,* here designated, MBT 10025003: AD-C3103!).

Amanita umbrinelloides A.E.Wood, *Austral. Syst. Bot.* 10(5): 731 (1997) [MB443177], *syn. nov. Type*: Wyong, Watagan State Forest, New South Wales, 13 June 1985, *A.E. Wood* 85/603 *& F.K. Taeker* (*holo*: UNSW DB16622!).

Illustrations. E.-J. Gilbert & J.B. Cleland, *in*: J. Bresadola, *Iconogr. Mycol.*, Suppl. 1, 27(3), Tab. 23–24 (1941). A.E. Wood, *Austral. Syst. Bot.* 10(5): 730, 732, Figs 2, 3 (1997).

Type description. Annotation of AD-C3103 in Cleland's hand (Figure 3): 'Amanita. Pileus hemispherical when young, then expanding up to 2½″. Dark olive. Edge striate when young. Completely enclosed in volva wh[ich] remains as a thick white crust 1″ diam on top, or is dispersed as whitish flakes. Volva remaining as white cup, later indistinct. Ring fixed, white, marked above *c.* gill lines. Just free. Stem ¾″ above Bulbous, 1″ diam, pointed below. White & *c.* hollow. Hymenoph[ore] free.

On ground, sandy. Milson Isl 14/4/13 (Watercolour 5 DIC[])]

Spores nearly spherical (a little elong.). Colourless 10.8 to 12.5 µ Large central nucleus, granular around. Small sps - Spores 9 µ or less. spherical or sl. oval *c.* [??] at one end.'

Basidiospores [80/2/1] (8–)9–12(–13) × (6–)7–10(–11) µm, (**L** = 9.8–10.8 µm; **L′** = 10.3 µm; **W** = 7.9–9.2 µm; **W′** = 8.6 µm; Q = (1.00–)1.10–1.33(–1.60); **Q** = 1.17–1.24; **Q′** = 1.21), hyaline, colourless, thin walled, smooth, inamyloid, subglobose to broadly ellipsoid, contents granular; apiculus sublateral, tapered, *c.* 1.0 × 1–5 µm, rounded. Clamp connections present. (Figures 4, 5)

Basidiomes agaricoid. *Pileus* 40–120 mm wide, up to 11 mm thick, convex to plane with depressed centre and decurved margin, vinaceous buff to clay buff to drab to hazel to cigar brown to mouse grey to dark olive (5B2–D4–6D–E5), without surface staining or bruising, slightly viscid when moist; margin slightly striate, not appendiculate. *Universal veil on pileus* adnate, initially crustose, breaking into floccose patches, white to dingy white to grey to vinaceous buff to clay buff (5C2–D2–6C3). *Lamellae* adnexed to free, close to subcrowded, white with pink tint to ivory white (B) to vinaceous buff (4–5A2), to 15 mm broad, margin concolorous or darker, fimbriate; lamellulae in several lengths, attenuate or subattenuate. *Stipe* 23–40 × 20–30 mm, cylindric or narrowing upwards or narrowing downwards, white or cream or with buff tint, surface smooth. *Partial veil* superior to median to inferior, membranous, descendent becoming adpressed, striate above, white or ivory white (B) or buff or dark grey. *Bulb* 7–27 × 9–30 mm, clavate or tapered or globose. *Remains of universal veil at top of bulb* a free limb to 20 mm high, white or vinaceous buff or clay buff or dark grey, or not apparent. *Pileus and stipe context* white, unchanging or becoming vinaceous buff in bulb, solid or becoming hollow; bulb often eaten out by insects. *Smell* none. *Spore deposit* white or ivory white (B). (Figure 6)

Basidiospores [220/11/8] (8–)9–12.5(–13) × (6–)7.5–10(–11) µm, (**L** = 9.4–11.5 µm; **L′** = 10.9 µm; **W** = 8.1–10.0 µm; **W′** = 8.8 µm; Q = (1.00–)1.11–1.37(–1.60); **Q** = 1.12–1.36; **Q′** = 1.23), hyaline,

Figure 3. Lectotype of *Amanita umbrinella* AD-C3103. A, B – water colour illustrations of two basidiomes (see the basidiomes labelled A and B in AD-C3103), reproduced from Cleland and Cheel (1914: Plate I, figs 1 and 2), as '*Amanita pantherina*'; C – AD-C3103, notes by J.B. Cleland; D – composite of underside and upperside of basidiomes A and B in AD-C3103, together with packet and annotations. Photographs by J. Percy-Bower (C, D) with permission from the South Australian Herbarium.

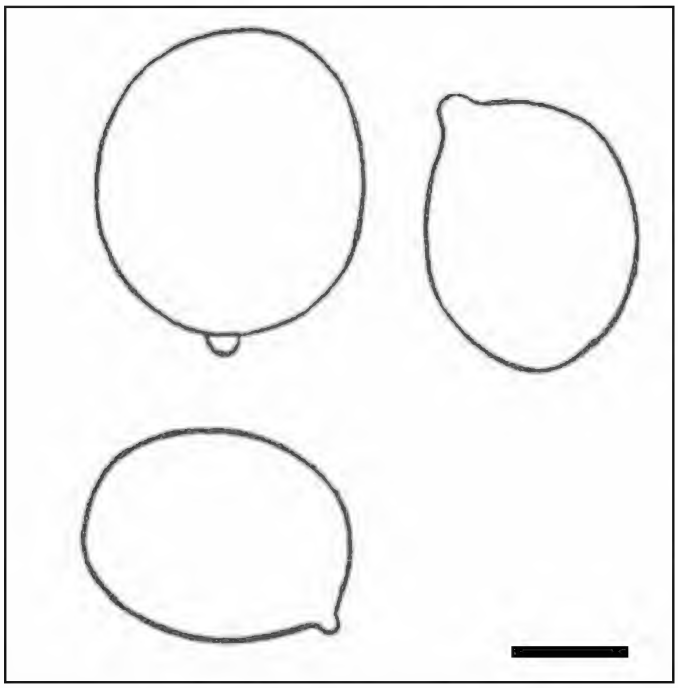

Figure 4. *Amanita umbrinella.* Spores from AD-C3103. Scale bar = 5 µm. Images reproduced from Gilbert (1940, Tab. XX, Fig. 3).

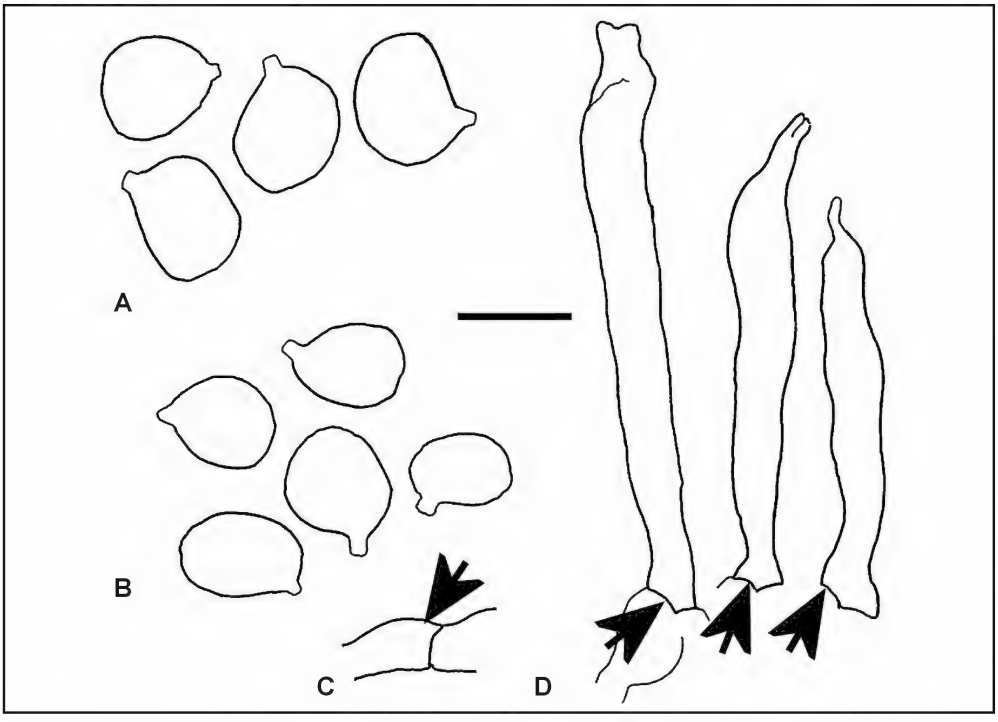

Figure 5. *Amanita umbrinella.* A – spores from lamella (AD-C3103A); B – spores from lamella (AD-C3103B); C – clamp connection from lamella trama (AD-C3103A); D – basidia showing basal clamp connections (AD-C3103B). Scale bar = 10 µm; clamp connections indicated by arrows. Images from *J.B. Cleland s.n.* (AD-C3103).

Figure 6. *Amanita umbrinella* basidiomes. Images from *E.M. Davison & P.J.N. Davison* EMD 11-2016 (PERTH 09577157). Photographs by E.M. Davison.

colourless, thin walled, smooth, inamyloid, subglobose to broadly ellipsoid to occasionally ellipsoid, contents monoguttulate or granular; apiculus sublateral, tapered or cylindric, *c.* 0.5–1.5 × 1–2 µm, rounded or truncate. *Pileipellis* up to 230 µm thick with a colourless or pale yellow gelatinised suprapellis up to 150 µm thick and pale yellow or pale yellowish brown subpellis, consisting of filamentous hyphae and frequent or infrequent vascular hyphae (inflated cells not observed); filamentous hyphae 2–20 µm wide with widest constricted at septa, radially orientated with some interweaving, thick walled, colourless or pale yellow or yellowish brown, gelatinising; vascular hyphae 2–15 µm wide, occasionally branched, pale yellow or pale brownish yellow or colourless; clamp connections very infrequent. *Pileus context* consisting of dominant or equal or frequent filamentous hyphae, inflated cells and infrequent or frequent vascular hyphae; filamentous hyphae 2–25 µm wide with widest constricted at septa, thin walled, colourless, gelatinising; inflated cells to 250 × 40 µm, clavate or ventricose or cylindric or ovoid, terminal, colourless, gelatinising; vascular hyphae 2–10 µm wide, occasionally branched, pale yellow or yellowish brown or colourless; clamp connections infrequent. *Lamella trama* bilateral, divergent. *Central stratum* up to 30 µm wide, consisting of filamentous hyphae and infrequent vascular hyphae (inflated cells not observed); filamentous hyphae 3–8 µm wide with widest constricted at septa, thin walled, colourless, axially orientated; vascular hyphae 4–15 µm wide, pale yellow; clamp connections infrequent. *Subhymenial base* with angle of divergence *c.* 15°–20° from central stratum, with filamentous hyphae following smooth broad curve to subhymenium, consisting of dominant or equal filamentous hyphae, inflated cells and frequent or very infrequent vascular hyphae; filamentous hyphae 3–15 µm wide, widest constricted at septa, thin walled, colourless; inflated cells up to 130 × 30 µm, thin walled, clavate or ellipsoid, colourless; vascular hyphae 3–15 µm wide, occasionally branched, pale yellow or pale yellowish brown or colourless; clamp connections frequent. *Subhymenium* ramose, basidia arising terminally from narrow or barely inflated hyphal segments 3–5 µm wide which become inflated to 10 µm; clamp connections frequent to abundant. *Lamella edge tissue* sterile with infrequent to frequent pyriform or ovoid or ellipsoid inflated cells; inflated cells up to 50 × 25 µm, with slightly thickened walls, colourless. *Basidia* [120/6/6] (44–)50–78(–87) × (10–)11–16(–18) µm, thin walled, colourless, *c.* 92% 4-spored, *c.* 6% 3-spored, *c.* 2% 2-spored, sterigmata to 8 µm, clamp connections abundant. *Universal veil on pileus* not layered, elements with no dominant orientation, consisting of equal or frequent filamentous hyphae, inflated cells and infrequent to frequent vascular hyphae; filamentous hyphae 2–20 µm wide with widest constricted at septa, colourless or pale brown, gelatinising; inflated cells to 120 × 80 µm when ovoid or to 70 × 70 µm when spherical or to 165 × 15 µm when clavate or to 75 × 50 µm when ellipsoid or to 55 × 30 µm when pyriform or to 140 × 45 µm when ventricose, terminal, colourless or with pale brown or pale greyish brown contents, gelatinising; vascular hyphae 3–9 µm wide, occasionally branched, pale yellowish brown or pale brown or pale yellow; clamp connections infrequent to frequent. *Universal veil on stipe base* not layered, elements with somewhat axial orientation, consisting of dominant or frequent filamentous hyphae, inflated cells and infrequent to frequent vascular hyphae; filamentous hyphae 2–12 µm wide, colourless, gelatinising; inflated cells to 70 × 50 µm, ovoid or spherical or pyriform or ellipsoid or clavate, terminal, pale brown or pale greyish brown, disarticulating, gelatinising; vascular hyphae 2–8 µm wide, occasionally branched, pale yellow or yellowish brown or colourless; clamp connections very infrequent. *Stipe context* longitudinally acrophysalidic, consisting of filamentous hyphae, dominant acrophysalides and infrequent vascular hyphae; filamentous hyphae 2–8 µm wide, thin walled, colourless; acrophysalides up to 500 × 40 µm, clavate or cylindric, terminal, colourless, gelatinising; vascular hyphae 3–12 µm wide, occasionally branched, pale yellow or yellowish brown or colourless; clamp connections infrequent. *Partial veil* not layered, elements with radial orientation, consisting of dominant filamentous hyphae, inflated cells and infrequent to abundant vascular hyphae; filamentous hyphae 2–30 µm wide with widest constricted at septa, colourless, gelatinising; inflated cells up to 150 × 20 µm, clavate or ovoid or ventricose or ellipsoid or pyriform, terminal, colourless, gelatinising; vascular hyphae 2–7 µm wide, occasionally branched, very pale yellow or colourless; clamp connections infrequent. (Figure 7)

Diagnostic features. Fruiting bodies are squat, small to large with a buff to dark brown to grey to dark olive pileus that is covered with patches of white to grey to buff universal veil. The gills are white, sometimes with a pink tinge, or ivory white or buff. The stipe is white or cream or buff with a membranous, white or greyish descendant partial veil that becomes adpressed on the stipe. The bulb and base of the stipe are often eaten out by insects. The spores are inamyloid, subglobose to broadly ellipsoid to ellipsoid. The

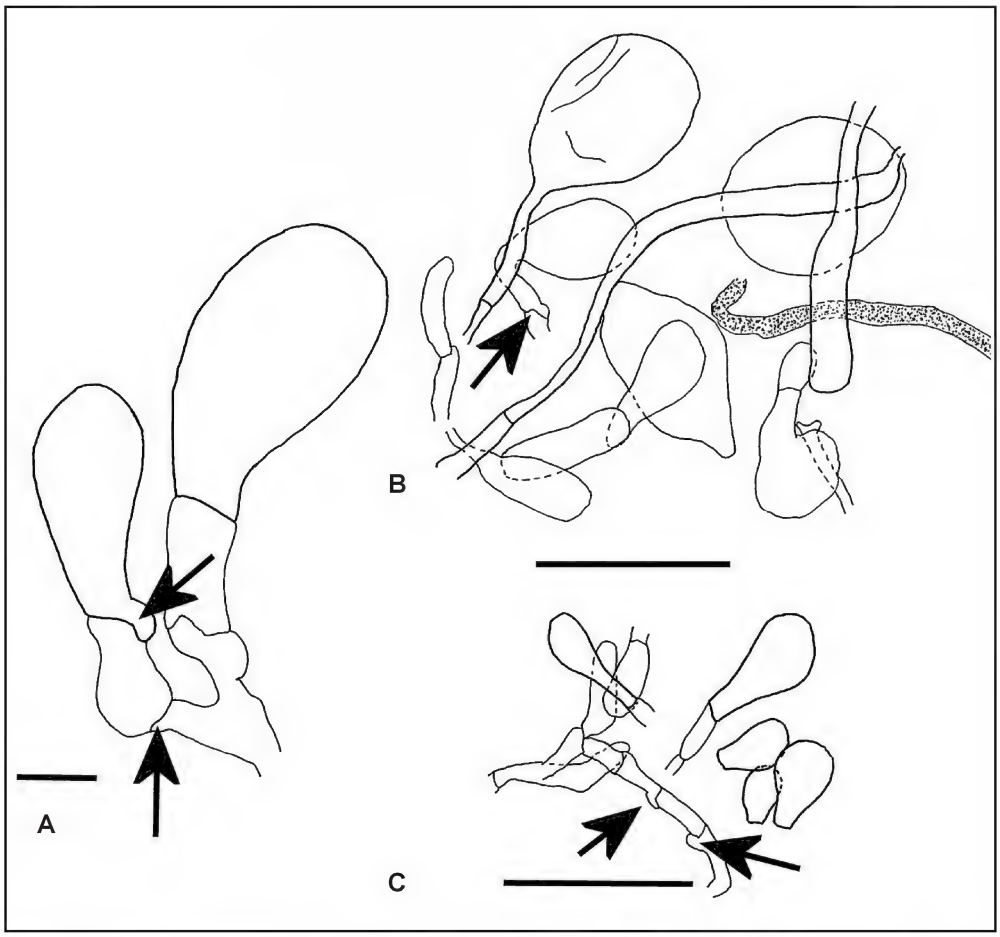

Figure 7. *Amanita umbrinella*. A – marginal cells; B – universal veil from pileus with vascular hypha (stippled), gentle squash; C – partial veil, gentle squash. Scale bars = 10 µm (A), 50 µm (B, C); clamp connections indicated by arrows. Images from *E.M. & P.J.N. Davison* EMD 11-2016 (PERTH 09577157).

universal veil on the pileus has elements with no dominant orientation and is composed of colourless filamentous hyphae and inflated cells with brown or greyish brown contents. Clamp connections are present in all tissues.

Other specimens examined. NEW SOUTH WALES: Howes Valley, 22 May 1986, *A.E. Wood* 86/167 & *F.K. Taeker* (UNSW DB22940); QUEENSLAND: Girraween National Park, 23 Mar. 2010, *P. Leonard* PL 100310 (BRI AQ0794062); SOUTH AUSTRALIA: Kaiserstuhl Conservation Park, 30 May 2009, *P.S. Catcheside* PSC 3003 (AD-C56186); Cox Scrub Conservation Park, 9 Apr. 2004, *P.S. Catcheside* PSC 1813, *D.E.A. Catcheside, A. & P. Schroeder* (AD-C56413); WESTERN AUSTRALIA: Lesueur National Park, 6 June 2010, *E.M. & P.J.N. Davison* EMD 12-2010 (PERTH 09576983); Shire of Manjimup, 3 June 2013, *E.M. & P.J.N. Davison* EMD 33-2013 (PERTH 09577122); Shire of Serpentine-Jarrahdale, 24 Apr. 2016, *E.M. & P.J.N. Davison* EMD 11-2016 (PERTH 09577157).

Phenology. Fruiting period is March to June.

Distribution and habitat. Singly or gregarious, in sand or sandy loam or loam or lateritic gravel, in sandy heath or dry eucalypt forest or moist eucalypt woodland. Nearby plants include *Acacia melanoxylon*,

Acacia spp., *Corymbia calophylla*, *Eucalyptus camaldulensis*, *E. cosmophylla*, *E. diversicolor*, *E. leucoxylon*, *E. patens*, *Eucalyptus* spp., *Leptospermum juniperinum* and *Melaleuca lanceolata*. Occurs in the Geraldton Sandplain Lesueur Sandplain GES02, Northern Jarrah Forest JAF01, Southern Jarrah Forest JAF02, Mt Lofty Ranges FLB01, Fleurieu KAN02, Sydney Basin Wollemi SYB04 and Inglewood Sandstones BBS18 IBRA subregions (Department of Agriculture, Water and the Environment 2012).

Conservation status. The species has a widespread distribution and does not appear to be under conservation threat in Western Australia (T. Llorens pers. comm.).

Typification. Among the original material cited by Gilbert (1941a), one collection (now identified as AD-C3103) and the associated illustration were cited as 'type', another collection was rather confusingly cited as 'syntype', and further collections were also cited. The AD material is selected as a lectotype to create certainty, especially since the term 'type' was applied to both a specimen and an illustration. Further details (especially the date) supporting the selected lectotype are included in the figure legends on Tab. XX in Gilbert (1940) and are quoted here:

> Fig. 3: '*A. umbrinella*, t. 23 (Australia. - Cleland: Collection type, n. 22, 14-IV-1913, water colour DIC n. 5, *Amanita pantherina*)'. Fig. 4: '*A. umbrinella*, t. 24 (Australia. - Cleland, Collection syntype n. 14, Photographie n. 40, sporée, *Amanita grisea*)'.

Notes. Microscopic examination of the lectotype (AD-C3103) shows the spores are subglobose to broadly ellipsoid and clamp connections are present in the lamellae and at the base of basidia. This has allowed sorting of all the collections based on spore shape. The 28S gene region shows that seven collections with similar shaped spores and clamp connections cluster in a well-supported clade (BS 96) (Figure 1). Additional support is provided by ITS cloned haplotypes that show 0.0–7.7% variation within an individual, and 3.4–12.8% between collections of this species (Table 4). The closest collection is *A. muriniflammea* (AD-C54952), which differs by 8.9–11.2%. Clones of *A. muriniflammea, A. horizontalis, A. doreta* and *A. cinereoalba* differ by 12.9–17.4%, 15.9–22.5%, 19.3–23.8% and 21.5–26.8% respectively (Table 4). The only sequence of the ITS gene region of *A. umbrinella* in GenBank is AY194981. This collection was probably from NSW; no voucher is available. This sequence shows 12.6–16.9% variation from the *A. umbrinella* collections used in our study; it may be a misidentification.

Wood (1997) describes *A. umbrinelloides* as being closely related to *A. umbrinella* but differing in having subglobose spores and the universal veil on the pileus being composed of dominant filamentous hyphae and infrequent inflated cells. Our examination of the type shows spores from both the lamellae and the partial veil are subglobose to broadly ellipsoidal ([38/2/1] (9.5–)10–15 × (8.5–)9–12(–13) µm; **L** = 12.2 µm; **W** = 10.4 µm; Q = (1.05–)1.08–1.27(–1.36); **Q** = 1.17) (N.B. some of the spores from the partial veil were swollen and appear to have been degraded by bacteria), which is within the range of *A. umbrinella*. Examination of a flake from the universal veil showed that it is composed of dominant filamentous hyphae and frequent inflated cells. In our opinion, the characters used by Wood are insufficient to distinguish *A. umbrinelloides* from *A. umbrinella*, and the two species are combined.

Amanita muriniflammea Tulloss, A.M.Young & A.E.Wood, as '*murinoflammeum*', *Mycotaxon* 56: 295 (1995) [MB580505]. *Type*: Blackbutt, Nanango Shire, Queensland, 5 January 1991, *A.M. Young* 1601 (*holo*: BRI AQ0642698!; *iso*: RET, YOUNG).

Illustration. R.E. Tulloss, A.M. Young & A.E. Wood, *Mycotaxon* 56: 296, 299, Figs 1–4 (1995).

Specimens examined. AUSTRALIAN CAPITAL TERRITORY: Black Mountain Reserve, 1 Feb. 1995, *H. Lepp* 1143 (CANB 574478.1); SOUTH AUSTRALIA: Porter Scrub Conservation Park, 31 May 2006, *P.S. Catcheside* PSC 2488 (AD-C54952); Mount George Conservation Park, 10 Oct. 2005, *P.S. Catcheside* PSC 2426 (AD-C56630).

Notes. The 28S gene region is available for a cited specimen (NY 66697) of *A. muriniflammea* (not

examined herein); this clusters with AD-C54952 with good support (BS 99) (Figure 1). Additional support is provided by ITS cloned haplotypes that show 2.7–4.9% variation within an individual, and 3.3–8.4% between collections of this species (Table 5).

Amanita muriniflammea and *A. umbrinella* are somewhat similar, however, they differ in colour of the pileus, which is light reddish brown becoming light brown to brownish grey in *A. muriniflammea*, whilst in *A. umbrinella* the mature pileus is darker and sometimes with olive tints. The stipe is longer in *A. muriniflammea* (base of pileus to top of bulb 23–40 mm in *A. umbrinella*, 80–110 mm in *A. muriniflammea*). The spores of *A. muriniflammea* are slightly larger than those of *A. umbrinella* ([201/10/5] (9.8–)10.2–13.2(–16.5) × (7–)8–10.5(–12.5) µm, **L′** = 11.6 µm, **W′** = 9.1 µm, compared with [220/11/8] (8–)9–12.5(–13) × (6–)7.5–10(–11) µm, **L′** = 10.9 µm, **W′** = 8.8 µm respectively), however, they are of similar shape (*A. muriniflammea*: Q = (1.02–)1.12–1.46(–1.65), **Q′** = 1.27; *A. umbrinella*: Q = (1.00–)1.11–1.37(–1.60), **Q′** = 1.23).

Molecular phylogenetic analysis of the *tef1-α* and *rpb2* shows that *A. muriniflammea* clusters separately from *A. umbrinella* (Figure 2A, B). ITS haplotypes of *A. muriniflammea* differ by up to 4.9% within collections, and by up to 8.4% between collections (Table 5), whilst they differ by up to 17.4% from those of *A. umbrinella* (Table 4).

Amanita horizontalis E.M.Davison & Giustiniano, *sp. nov*. [MB855950].

Type: Shire of Manjimup, Western Australia [precise locality withheld for conservation reasons], 2 June 2013, *E.M. & P.J.N. Davison* EMD 27-2013 (*holo*: PERTH 09577254!).

Basidiomes agaricoid. *Pileus* 40–125 mm wide, up to 20 mm thick, convex to plane with depressed centre and decurved margin, vinaceous buff to clay buff to drab to patchy grey to almost black near margin (5B3–E2–6C4–D4), without surface staining or bruising, slightly viscid when moist; margin slightly striate, not appendiculate. *Universal veil on pileus* adnate, initially crustose, breaking into flat patches, white to pale vinaceous buff to clay buff to drab (5B2–E2–6C2). *Lamellae* adnexed to narrowly adnate, close to subcrowded, white to ivory white (B) to very pale grey, to 15 mm broad; margin concolorous or brown, fimbriate; lamellulae in several lengths, truncate or subattenuate or attenuate. *Stipe* 55–85 × 9–18 mm, cylindric or narrowing upwards, white or ivory white (B) or very pale grey, surface smooth or fibrillose. *Partial veil* superior to median, thick, membranous, patent becoming descendent, striate above, white or ivory white (B) or greyish or pale vinaceous buff or pale drab (5E2–6B2–7C2). *Bulb* 12–22 × 13–22 mm, ovoid or subglobose or fusiform or clavate, brownish. *Remains of universal veil at top of bulb* a free limb to 20 mm high, white or pale, or not apparent. *Pileus and stipe context* white, unchanging or becoming brownish in bulb, solid or becoming hollow. *Smell* none. *Spore deposit* white or ivory white (B). (Figure 8)

Basidiospores [260/13/8] (10–)11–15(–17) × 7–10(–11) µm, (**L** = 11.8–14.7 µm; **L′** = 12.7 µm; **W** = 7.4–10.1 µm; **W′** = 8.5 µm; Q = (1.18–)1.28–1.79(–2.00); **Q** = 1.32–1.75; **Q′** = 1.50), hyaline, colourless, thin walled, smooth, inamyloid, ellipsoid to elongate, contents monoguttulate; apiculus sublateral, cylindric or tapered, *c.* 0.5–1.5 × 1–2 µm, truncate or rounded. *Pileipellis* up to 300 µm thick with a colourless gelatinised suprapellis up to 150 µm thick and pale yellow or pale yellowish brown subpellis, consisting of filamentous hyphae and frequent or infrequent vascular hyphae (inflated cells not observed); filamentous hyphae 2–12 µm wide with widest constricted at septa, radially orientated with some interweaving, thick walled, colourless or yellowish brown, gelatinising; vascular hyphae 2–15 µm wide, occasionally branched, pale yellow or pale brownish yellow or colourless; clamp connections very infrequent. *Pileus context* consisting of dominant or equal or frequent filamentous hyphae, inflated cells and infrequent or frequent vascular hyphae; filamentous hyphae 2–35 µm wide with widest constricted at septa, thin walled, colourless; inflated cells to 250 × 55 µm, clavate or ventricose or cylindric or ovoid, terminal, colourless; vascular hyphae 2–18 µm wide, branched, pale yellow or yellowish brown or colourless; clamp connections very infrequent. *Lamella trama* bilateral, divergent. *Central stratum* up to 40 µm wide, consisting of filamentous hyphae and very infrequent vascular hyphae (inflated cells not observed); filamentous hyphae

3–12 µm wide with widest constricted at septa, thin walled, colourless, axially orientated; vascular hyphae 3–7 µm wide, pale yellow or colourless; clamp connections infrequent. *Subhymenial base* with angle of divergence *c.* 20°–30° from central stratum, with filamentous hyphae following smooth broad curve to subhymenium, consisting of dominant or equal filamentous hyphae, inflated cells and very infrequent vascular hyphae; filamentous hyphae 2–25 µm wide, widest constricted at septa, thin walled, colourless; inflated cells up to 200 × 35 µm, thin walled, clavate or ventricose or cylindrical or ovoid, colourless; vascular hyphae 2–6 µm wide, occasionally branched, pale yellow or colourless; clamp connections frequent. *Subhymenium* ramose; basidia arising terminally from narrow or barely inflated hyphal segments 4–6 µm wide that become inflated to 20 µm; clamp connections frequent to abundant. *Lamella edge tissue* sterile with infrequent to frequent clavate or pyriform or sphaeropedunculate or ovoid inflated cells; inflated cells up to 50 × 20 µm, with thin or slightly thickened walls, colourless. *Basidia* [140/7/7] (36–)38–87(–95) × (8–)9–18(–19) µm, thin walled, colourless, *c.* 83% 4-spored, *c.* 13% 3-spored, *c.* 3% 2-spored, *c.* 1% 1-spored, sterigmata to 7 µm, clamp connections abundant. *Universal veil on pileus* not layered, elements with no dominant orientation, consisting of dominant or equal or frequent filamentous hyphae, inflated cells and infrequent to abundant vascular hyphae; filamentous hyphae 2–12 µm wide with widest constricted at septa, colourless or pale yellow, gelatinising; inflated cells to 100 × 55 µm when ovoid or to 70 × 70 µm when spherical or to 120 × 20 µm when clavate or to 120 × 55 µm when pyriform or to 90 × 35 µm when ellipsoid, terminal, colourless or with pale brown contents, gelatinising; vascular hyphae 2–10 µm wide, occasionally branched, pale yellow or yellowish brown or colourless; clamp connections infrequent. *Universal veil on stipe base* not layered, elements with somewhat axial orientation, consisting of dominant or equal filamentous hyphae, inflated cells and vascular hyphae; filamentous hyphae 2–20 µm wide, thick walled, colourless, gelatinising; inflated cells to 100 × 60 µm, ovoid or clavate or spherical or ellipsoid or ventricose, terminal, colourless or pale brown, gelatinising; vascular hyphae 3–15 µm wide, branched, pale yellow or yellowish brown; clamp connections very infrequent. *Stipe context* longitudinally acrophysalidic, consisting of filamentous hyphae, dominant acrophysalides and infrequent to frequent vascular hyphae; filamentous hyphae 2–10 µm wide, thin walled, colourless; acrophysalides up to 260 × 50 µm, clavate or cylindric or ventricose, terminal, colourless; vascular hyphae 3–11 µm wide, occasionally branched, pale yellow or yellowish brown or colourless; clamp connections infrequent. *Partial veil* layered, elements with radial orientation, consisting of dominant filamentous hyphae, inflated cells and frequent to infrequent vascular hyphae; filamentous hyphae 2–10 µm wide with widest constricted at septa, colourless, gelatinising; inflated cells up to 160 × 20 µm, clavate or ovoid or spherical or pyriform, terminal, colourless, gelatinising; vascular hyphae 2–12 µm wide, occasionally branched, pale yellow or colourless; clamp connections infrequent. (Figure 9)

Diagnostic features. Fruiting bodies tall, small to large, with a clay buff to drab pileus that is covered with patches of clay buff to drab universal veil. The gills are white to ivory white or very pale grey. The stipe is white with a thick, white or greyish or brownish partial veil that is initially horizontal before collapsing. The spores are inamyloid, ellipsoid to elongate. The universal veil on the pileus has elements with no dominant orientation and is composed of colourless filamentous hyphae and inflated cells with brown contents. Clamp connections are present in all tissues.

Other specimens examined. SOUTH AUSTRALIA: Flinders Chase National Park, 19 July 2005, *P.S. Catcheside* PSC 2284 *& D.E.A. Catcheside* (AD-C55036); TASMANIA: Hobart, 7 Dec. 2010, *G. Gates* s.n. (HO 559528); VICTORIA: Eastern Highlands, 18 Apr. 1978, *F.M. Cole* s.n. (MEL 2314568); WESTERN AUSTRALIA: Melville, 11 June 2006, *E.M. & P.J.N. Davison* EMD 2-2006 (PERTH 09577203); Shire of Waroona, 1 June 2019, *E.M. & P.J.N. Davison* EMD 18-2019 (PERTH 09576916); Shire of Mundaring, 16 June 2013, *E.M. & P.J.N. Davison* EMD 38-2013 (PERTH 09577211); Brixton Street Wetland, Perth, 27 June 2007, *C. Parker* E 8477 (PERTH 08093229).

Phenology. Fruiting period is April to December.

Distribution and habitat. In sand or loam or lateritic gravel, in Banksia and eucalypt woodland. Nearby plants include *Corymbia calophylla*, *Eucalyptus cladocalyx*, *E. marginata*, *Eucalyptus* spp. and *Melaleuca lanceolata*. Occurs in the Perth SWA02, Northern Jarrah Forest and Southern Jarrah Forest JAF01 and

Figure 8. *Amanita horizontalis* basidiomes. Images from *E.M. Davison & P.J.N. Davison* EMD 27-2013 (PERTH 09577254). Photographs by E.M. Davison.

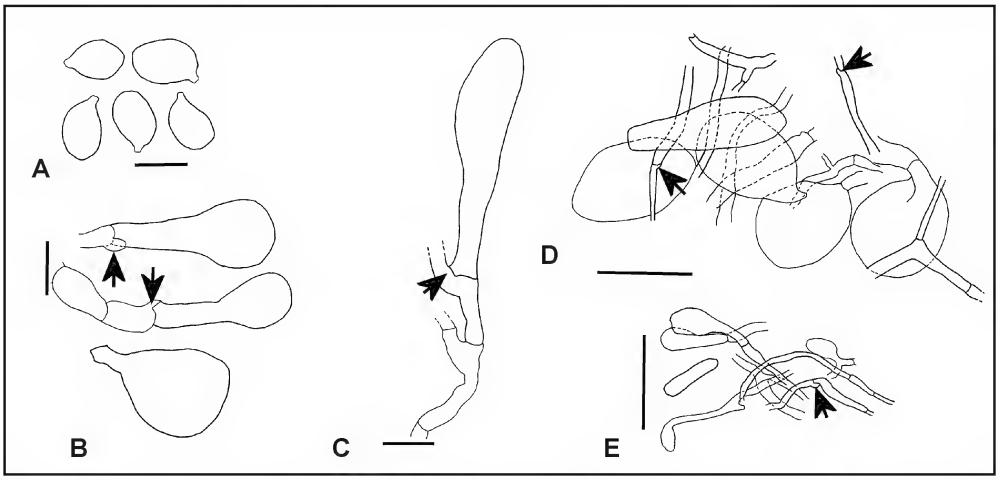

Figure 9. *Amanita horizontalis*. A – spores from spore print; B – marginal cells; C – basidium; D – universal veil on pileus, gently squashed; E – partial veil, gently squashed. Scale bars = 10 µm (A–C), 50 µm (D, E); clamp connections indicated by arrows. Images from *E.M. & P.J.N. Davison* EMD 27-2013 (PERTH 09577254).

JAF02, Kangaroo Island KAN01, Tasmanian South East TSE01 and South Eastern Highlands Southern Fall SEH01 IBRA subregions (Department of Agriculture, Water and the Environment 2012).

Conservation status. The species has a widespread distribution and does not appear to be under conservation threat in Western Australia (T. Llorens pers. comm.).

Etymology. The epithet is from the Latin *horizontalis* (horizontal), in reference to the partial veil that is horizontal in young basidiomes.

Notes. The 28S phylogeny (Figure 1) placed sequences of *A. horizontalis* within sect. *Amarrendiae*. *Amanita horizontalis* differs from *A. umbrinella* in its somewhat paler pileus, longer stipe, and its partial veil, which is initially horizontal before collapsing, whilst that of *A. umbrinella* is descendent before becoming adpressed. Also, *A. horizontalis* appears less attractive to insects because the stipe base is usually intact whilst it is often eaten out in *A. umbrinella*. These species differ in spore shape, those of *A. horizontalis* being ellipsoid to elongate (**Q** = 1.32–1.75), whilst those of *A. umbrinella* are subglobose to broadly ellipsoid to ellipsoid (**Q** = 1.12–1.36). The spores of *A. horizontalis* are longer than those of *A. umbrinella* ([260/13/8] **L** = 11.8–14.7 µm; **L′** = 12.7 µm, compared with [220/11/8] **L** = 9.4–11.5 µm; **L′** = 10.9 µm respectively). The spores of *A. horizontalis* differ in shape from those of *A. muriniflammea*, being ellipsoid to elongate (**Q** = 1.32–1.75), compared to being subglobose to broadly ellipsoid to ellipsoid (**Q** = 1.16–1.43). Clamp connections are present in all tissues of *A. horizontalis* apart from MEL 2314568 where they are very infrequent.

ITS cloned haplotypes show there is considerable variation between the clones of *A. horizontalis*, with 0.0–10.0% variation within an individual and 3.1–16.8% variation between collections of this species (Table 6). Collection HO 559528 is consistently more variable than the other collections, but clusters with other collections of *A. horizontalis* in other gene regions (Figures 1, 2A, B, D).

Two collections, AD-C49442 and MEL 2432442, which have elongate and ellipsoid spores respectively, do not cluster with *A. horizontalis*, but have been designated as *A.* aff. *horizontalis* for convenience because their spore size and shape is closest to *A. horizontalis*, but they are not that species. Phylogenetic analysis of the 28S region shows they cluster with *A. doreta* (Figure 1), whilst in the *tef-1* analysis MEL 2432442 clusters with *A. umbrinella* whilst AD-C49442 clusters with *A. cinereoalba* (Figure 2A). In the β-tubulin analysis, MEL 2432442 clusters with *A. umbrinella* whilst AD-C49442 clusters with

A. doreta (Figure 2C). In the *rpb2* and concatenated analyses both collections cluster together, close to *A. horizontalis* (Figures 2B, D). Cloned haplotypes of the ITS region of these two collections show 24.3–25.7% variation between them, and up to 20.5% (MEL 2432442) and 27.4% (AD-C49442) variation when compared with haplotypes of *A. horizontalis* (Table 6).

On the basis of the patent partial veil, spore size and shape, and genetic sequences, *A. horizontalis* is described as a new species.

Amanita doreta E.M.Davison & Giustiniano, *sp. nov*. [MB855952].

Type: Scott National Park, Western Australia [precise locality withheld for conservation reasons], 13 June 2018, *E.M. Davison & P.J.N. Davison* EMD 22-2018 (*holo*: PERTH 09703357!).

Basidiomes agaricoid. *Pileus* 85–112 mm wide, up to 10 mm thick, convex, clay buff to hazel (5C3–6D4), without surface staining or bruising, slightly viscid when moist; margin slightly striate, not appendiculate. *Universal veil on pileus* adnate, crustose, breaking into flat patches, white to pale. *Lamellae* adnexed to narrowly adnate, close, white to ivory white (B), to 12 mm broad; margin concolorous, fimbriate; lamellulae in several lengths, truncate or attenuate. *Stipe* 85–100 × 18–31 mm, cylindric or narrowing upwards, white, surface smooth. *Partial veil* superior to median, wide to narrow, thick, membranous, patent, striate above, white. *Bulb* 10–35 × 25–32 mm, globose to tapered, white. *Remains of universal veil at top of bulb* a few brown flakes, or a free limb to 7 × 2 mm, white. *Pileus and stipe context* white, becoming clay buff in stipe and bulb, solid or becoming hollow. *Smell* none. *Spore deposit* white or ivory white (B). (Figure 10)

Basidiospores [40/2/2] 11–13.5 × (6–)7–8.5(–9) µm, (**L** = 12.0–12.4 µm; **L′** = 12.2 µm; **W** = 7.2–7.8 µm; **W′** = 7.5 µm; Q = (1.38–)1.44–1.86(–1.93); **Q** = 1.55–1.73; **Q′** = 1.64), hyaline, colourless, thin walled, smooth, inamyloid, ellipsoid to elongate, contents monoguttulate; apiculus sublateral, cylindric, *c*. 1–1.5 × 1.5 µm, truncate. *Pileipellis* up to 350 µm thick with a colourless gelatinised suprapellis up to 200 µm thick and pale greyish yellow or pale yellow subpellis, consisting of filamentous hyphae and frequent or abundant vascular hyphae (inflated cells not observed); filamentous hyphae 2–12 µm wide, radially orientated with some interweaving, thick walled, colourless, gelatinising; vascular hyphae 2–12 µm wide, occasionally branched, pale yellow or pale brownish yellow; clamp connections very infrequent. *Pileus context* consisting of filamentous hyphae, dominant inflated cells and frequent or abundant vascular hyphae; filamentous hyphae 2–30 µm wide with widest constricted at septa, thin walled, colourless; inflated cells to 300 × 70 µm, ventricose or clavate or ovoid, terminal, colourless; vascular hyphae 3–15 \ µm wide, branched, pale yellow or colourless; clamp connections very infrequent. *Lamella trama* bilateral, divergent. *Central stratum* up to 40 µm wide, consisting of filamentous hyphae and very infrequent vascular hyphae (inflated cells not observed); filamentous hyphae 5–20 µm wide, thin walled, colourless, axially orientated; vascular hyphae 2 µm wide, colourless; clamp connections infrequent to frequent. *Subhymenial base* with angle of divergence *c*. 20°–25° from central stratum, with filamentous hyphae following smooth broad curve to subhymenium, consisting of dominant or equal filamentous hyphae, inflated cells and frequent or very infrequent vascular hyphae; filamentous hyphae 3–20 µm wide, widest constricted at septa, thin walled, colourless; inflated cells up to 200 × 50 µm, thin walled, clavate or cylindrical or ovoid or pyriform, colourless; vascular hyphae 3–10 µm wide, occasionally branched, pale yellow or colourless; clamp connections frequent to abundant. *Subhymenium* ramose; basidia arising terminally from narrow or barely inflated hyphal segments 4–13 µm wide; clamp connections abundant. *Lamella edge tissue* sterile with frequent to abundant pyriform or clavate or cylindric or ovoid inflated cells; inflated cells up to 60 × 15 µm, with slightly thickened walls, colourless, disarticulating. *Basidia* [40/2/2] (53–)62–90(–105) × (8–)12–14 µm, thin walled, colourless, *c*. 98% 4-spored, *c*. 2% 3-spored, sterigmata to 7 µm, clamp connections abundant. *Universal veil on pileus* not layered, elements with no dominant orientation, consisting of equal or less frequent filamentous hyphae, inflated cells and infrequent vascular hyphae; filamentous hyphae 3–15 µm wide with widest constricted at septa, colourless, gelatinising; inflated cells to 90 × 50 µm when ovoid or to 115 × 35 µm when clavate or to 70 × 70 µm when spherical or to 110 × 60 µm when ellipsoid, terminal or occasionally

Figure 10. *Amanita doreta* basidiomes. Images from *E.M. Davison & P.J.N. Davison* EMD 22-2018 (PERTH 09703357). Photographs by E.M. Davison.

in chains of 2, colourless, gelatinising; vascular hyphae 2–8 µm wide, occasionally branched, pale yellow; clamp connections infrequent. *Universal veil on stipe base* layered or not layered, elements with somewhat axial orientation; inner layer thin (when layered), of filamentous hyphae (inflated cells and vascular hyphae not observed); filamentous hyphae 2–3 µm wide, thick walled, colourless, gelatinising; clamp connections not observed; outer layer wide (when layered), of dominant filamentous hyphae, infrequent inflated cells and frequent or infrequent vascular hyphae; filamentous hyphae 2–10 µm wide, colourless, gelatinising; inflated cells to 150 × 60 µm, clavate or ovoid or cylindric, terminal, colourless, gelatinising; clamp connections very infrequent. *Stipe context* longitudinally acrophysalidic, consisting of filamentous hyphae, dominant acrophysalides and infrequent to frequent vascular hyphae; filamentous hyphae 2–8 µm wide, thin walled, colourless; acrophysalides up to 350 × 35 µm, clavate, terminal, colourless, gelatinising; vascular hyphae 3–10 µm wide, occasionally branched, pale yellow or yellowish brown; clamp connections infrequent. *Partial veil* layered, elements with radial orientation; upper layer compact, consisting of dominant filamentous hyphae, inflated cells and very infrequent vascular hyphae; filamentous hyphae 3–15 µm wide, colourless, gelatinising; inflated cells up to 100 × 15 µm, cylindric, terminal, colourless; vascular hyphae 3–6 µm wide, pale yellow; clamp connections very infrequent; lower layer open, consisting of dominant filamentous hyphae, inflated cells and very infrequent vascular hyphae; filamentous hyphae 2–10 µm wide, colourless, gelatinising; inflated cells up to 80 × 30 µm ovoid or clavate, terminal, colourless; vascular hyphae 2 µm wide, pale yellow; clamp connections infrequent. (Figure 11)

Diagnostic features. Fruiting bodies medium to large with a clay buff to hazel pileus that is covered with thick, felted, white universal veil that breaks into patches. The gills are white to ivory white. The stipe is white with a thick, wide to narrow, membranous, patent partial veil. The spores are inamyloid, ellipsoid to elongate. The universal veil on the pileus has elements with no dominant orientation and is composed of colourless filamentous hyphae and inflated cells. Clamp connections are present in all tissues.

Other specimens examined. WESTERN AUSTRALIA: Shire of Cuballing, 16 May 2016, *E.M. & P.J.N. Davison* EMD 20-2016 (PERTH 09578811).

Phenology. Fruiting period is May to June.

Distribution and habitat. In sandy soil in Allocasuarina Woodland and low Jarrah Marri Forest. Nearby

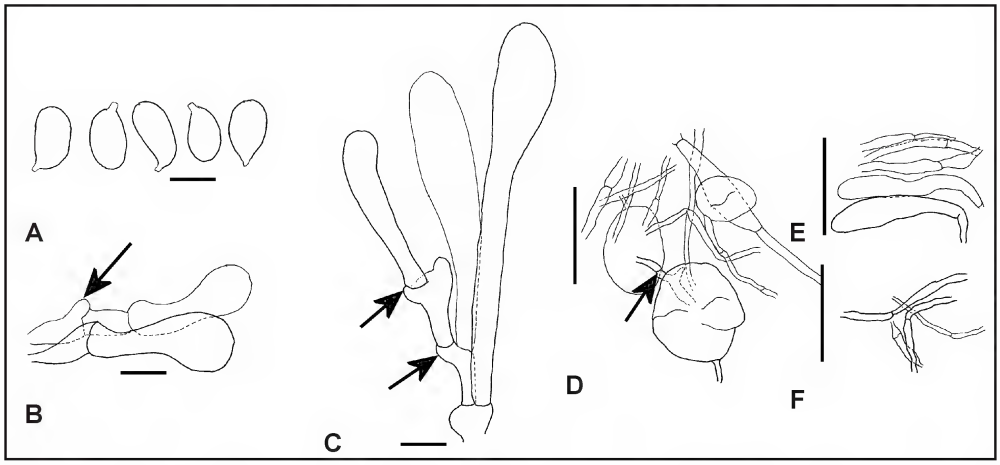

Figure 11. *Amanita doreta*. A – spores from spore print; B – marginal cells; C – basidia; D – universal veil on pileus, gently squashed; E – upper part of partial veil, gently squashed; F – lower part of partial veil, gently squashed. Scale bars = 10 µm (A–C), 50 µm (D–F); clamp connections indicated by arrows. Images from *E.M. & P.J.N. Davison* EMD 22-2018 (PERTH 09703357).

plants include *Agonis flexuosa*, *Allocasuarina huegeliana*, *Corymbia calophylla* and *Eucalyptus marginata*. Occurs in the Avon Wheatbelt Katanning AVW02 and Warren WAR01 IBRA subregions (Department of Agriculture, Water and the Environment 2012).

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.).

Etymology. The epithet is from the Greek *doretos* (generous, freely given), in thanks to the staff and volunteers at the WA Herbarium who have assisted us over many years.

Notes. The 28S phylogeny (Figure 1) placed sequences of *A. doreta* within sect. *Amarrendiae*. In the other phylogenetic analyses, the two collections of *A. doreta* cluster together (Figures 1, 2A, B, D).

The pileus is similar in colour to that of *A. umbrinella*, *A. muriniflammea* and *A. horizontalis*; however, its spores differ in shape from those of *A. umbrinella* and *A. muriniflammea*, being ellipsoid to elongate (Q = (1.38–)1.44–1.86(–1.93), **Q′** = 1.64), not subglobose to broadly ellipsoid to ellipsoid (Q = (1.00–)1.11–1.37(–1.60), **Q′** = 1.23; (1.02–)1.12–1.46(–1.65), **Q′** = 1.27 respectively). The spores of *A. doreta* are of similar size and shape to those of *A. horizontalis* (**L** = 12.0–12.4 × **W** = 7.2–7.8 µm, **Q** = 1.55–1.73 compared with **L** = 11.8–14.7 × **W** = 7.4–10.1 µm, **Q** = 1.32–1.75 respectively).

ITS cloned haplotypes of *A. doreta* show that there is considerable variation between the clones. They show 0.4–8.0% variation within an individual and 8.7–14.0% variation between collections of this species (Table 7). However, they show 18.2–24.7% variation when compared with collections of *A. horizontalis* (Table 6). On this basis, *A. doreta* is described as a new species.

Amanita cinereoalba E.M.Davison, Giustiniano & P.S.Catches., *sp. nov*. [MB855954].

Type: Mount Remarkable National Park, South Australia, 32°48′10″ S 138°2′22″ E, 20 July 2016, *P.S. & D.E.A. Catcheside* PSC 4466 (*holo*: AD-C60063!).

Basidiomes agaricoid. *Pileus* 23–55 mm wide, up to 6 mm thick, convex, pale grey to smoke grey to pinkish drab to dark brown, without surface staining or bruising, slightly tacky when moist; margin not striate, not appendiculate. *Universal veil on pileus* adnate, as flat patches, white to milky coffee. *Lamellae* adnexed, close to moderately distant, white to white-cream to white-cream with pink tint to brownish, to 5 mm broad; margin finely fimbriate; lamellulae in several lengths, truncate or attenuate, infrequent. *Stipe* 12–34 × 7–11 mm, cylindric or narrowing upwards, white or whitish brown, surface smooth or fibrillose. *Partial veil* inferior, membranous, descendent, evanescent, white to whitish grey. *Bulb* 10–12 × 15–18 mm, sub-globose, white. *Remains of universal veil at top of bulb* not obvious or a flimsy membrane to 15 mm high, flaring, white with smoke grey margin. *Pileus and stipe context* white, solid or becoming hollow. (Figure 12)

Basidiospores [140/7/3] (11–)12–15.5(–16) × (8–)8.5–11(–13) µm, (**L** = 13.0–14.5 µm; **L′** = 13.8 µm; **W** = 8.7–10.4 µm; **W′** = 9.8 µm; Q = (1.18–)1.25–1.60(–1.74); **Q** = 1.36–1.50; **Q′** = 1.42), hyaline, colourless, thin walled, smooth, inamyloid, broadly ellipsoid to ellipsoid, contents monoguttulate or granular; apiculus sublateral, cylindric, *c.* 1–1.5 × 1.5–2 µm, tapered, rounded. *Pileipellis* up to 170 µm thick with a colourless or pale brown gelatinised suprapellis up to 90 µm thick and pale brown or pale yellow subpellis, consisting of filamentous hyphae and infrequent or frequent vascular hyphae (inflated cells not observed); filamentous hyphae 3–8 µm wide, radially orientated with some interweaving, thick walled, colourless, gelatinising; vascular hyphae 3–12 µm wide, occasionally branched, pale yellow or pale brownish yellow; clamp connections very infrequent. *Pileus context* consisting of filamentous hyphae, dominant inflated cells and frequent to infrequent vascular hyphae; filamentous hyphae 2–30 µm wide with widest constricted at septa, thin walled, colourless; inflated cells to 250 × 70 µm, clavate or ventricose or ovoid or cylindrical, terminal, colourless; vascular hyphae 3–8 µm wide, branched, colourless or pale yellow;

Figure 12. *Amanita cinereoalba* basidiomes. Images from *P.S. & D.E.A. Catcheside* PSC 4466 (AD-C60063). Photograph by P.S. Catcheside.

clamp connections very infrequent. *Lamella trama* bilateral, divergent. *Central stratum* up to 50 µm wide, consisting of filamentous hyphae (inflated cells and vascular hyphae not observed); filamentous hyphae 5–12 µm wide, thin walled, colourless, axially orientated; clamp connections infrequent. *Subhymenial base* with angle of divergence *c.* 20° from central stratum, with filamentous hyphae following smooth broad curve to subhymenium, consisting of dominant filamentous hyphae, inflated cells and infrequent to frequent vascular hyphae; filamentous hyphae 3–20 µm wide, widest constricted at septa, thin walled, colourless; inflated cells up to 100 × 40 µm, thin walled, clavate or ovoid or ventricose; vascular hyphae 3–10 µm wide, occasionally branched, pale yellow or colourless; clamp connections infrequent. *Subhymenium* ramose; basidia arising terminally from narrow or barely inflated hyphal segments 4–13 µm wide; clamp connections frequent. *Lamella edge tissue* sterile with frequent pyriform or clavate or ovoid inflated cells; inflated cells up to 40 × 20 µm, with slightly thickened walls, colourless. *Basidia* [60/3/3] (40–)42–70(–80) × 10–14 µm, thin walled, colourless, *c.* 56% 4-spored, *c.* 7% 3-spored, *c.* 30% 2-spored, *c.* 7% 1-spored, sterigmata to 9 µm, clamp connections abundant. *Universal veil on pileus* not layered, elements with no dominant orientation, consisting of equal or frequent filamentous hyphae, inflated cells and frequent or infrequent vascular hyphae; filamentous hyphae 3–20 µm wide with widest constricted at septa, colourless, gelatinising; inflated cells to 110 × 90 µm when ovoid or to 60 × 60 µm when spherical or to 75 × 60 µm when ellipsoid or to 90 × 45 µm when pyriform, terminal, colourless or pale greyish brown or yellowish brown contents, disarticulating, gelatinising; vascular hyphae 2–25 µm wide, occasionally branched, pale yellow; clamp connections infrequent. *Universal veil on stipe base* not layered, elements with somewhat axial orientation, composed of dominant or equal filamentous hyphae and inflated cells (vascular hyphae not seen); filamentous hyphae 2–10 µm wide, colourless; inflated cells to 160 × 55 µm, pyriform or clavate or ovoid or spherical or ventricose, terminal, colourless or with very pale grey contents, gelatinising; clamp connections very infrequent. *Stipe context* longitudinally acrophysalidic, consisting of filamentous hyphae, dominant acrophysalides and frequent or infrequent

vascular hyphae; filamentous hyphae 2–8 µm wide, thin walled, colourless; acrophysalides up to 450 × 50 µm, clavate or cylindric or ventricose, terminal, colourless, gelatinising; vascular hyphae 2–9 µm wide, occasionally branched, pale yellow or colourless; clamp connections infrequent. *Partial veil* not layered, elements with radial orientation, composed of frequent or dominant filamentous hyphae, inflated cells and infrequent vascular hyphae; filamentous hyphae 2–12 µm wide, widest constricted at septa, disarticulating, colourless; inflated cells up to 400 × 50 µm, clavate or ovoid or spherical, colourless; vascular hyphae 2–12 µm wide, pale yellow or colourless. (Figure 13)

Diagnostic features. Fruiting bodies squat, very small to medium with grey to drab with a pinkish tint to dark brown pileus that has patches of a white to milky coffee universal veil. The gills are white to whitish cream with a pink tint. The stipe is white, with an inferior white to greyish white, evanescent partial veil. The spores are large, broadly ellipsoid to ellipsoid and inamyloid. The universal veil on the pileus has elements with no dominant orientation and is composed of colourless filamentous hyphae and inflated cells that are initially colourless but develop brownish contents. Clamp connections are present in all tissues.

Other specimens examined. SOUTH AUSTRALIA: Mount Remarkable National Park, 16 Aug. 2005, *P.S. Catcheside* PSC 2360 (AD-C53026); Mount Remarkable National Park, 16 Aug. 2005, *P.S. Catcheside* PSC 2365 (AD-C53045).

Phenology. Fruiting period is July to August.

Distribution and habitat. Gregarious or singly in grass and moss in a sandstone gorge. Nearby plants include *Allocasuarina* sp., *Callitris glaucophylla*, *Eucalyptus camaldulensis* and *Exocarpus cupressiformis*. Occurs in the Southern Flinders FLB04 IBRA subregion (Department of Agriculture, Water and the Environment 2012).

Etymology. The epithet is from the Latin *cinereus* (ash grey) + *albus* (white), meaning greyish white,

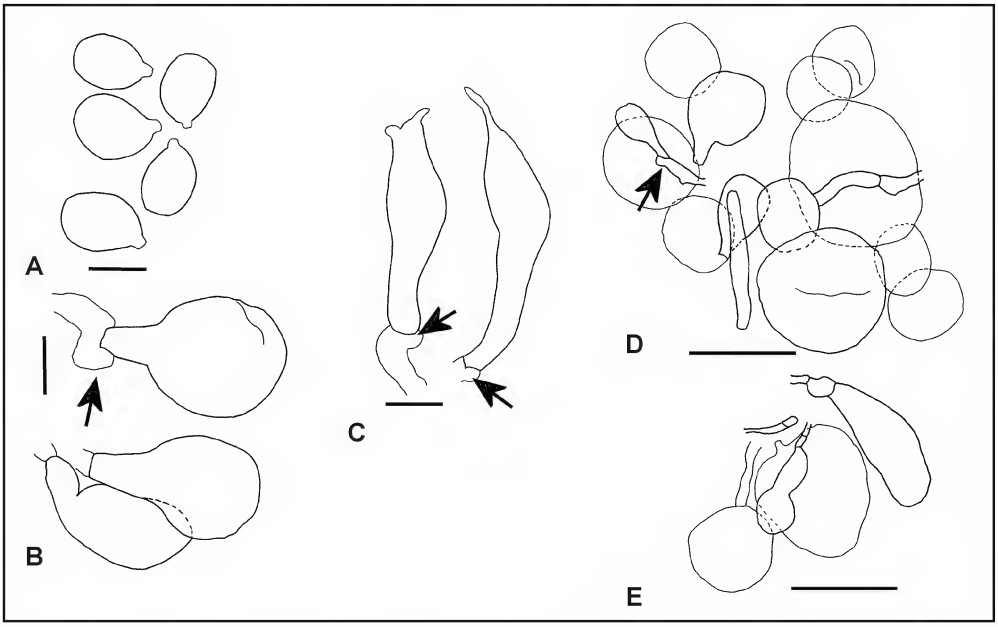

Figure 13. *Amanita cinereoalba*. A – spores from lamella; B – marginal cells; C – basidia; D – universal veil from pileus, gently squashed; E – partial veil, gently squashed. Scale bars = 10 µm (A–C), 50 µm (D, E); clamp connections indicated by arrows. Images from *P.S. & D.E.A. Catcheside* PSC 4466 (AD-C60063).

referring to the colour of the partial veil.

Notes. The 28S phylogeny (Figure 1) placed a sequence of *A. cinereoalba* within sect. *Amarrendiae*, where it clusters with the sequestrate species *A. grandis* and *A. oleosa* (BS 99).

Amanita cinereoalba is smaller than the other species described in this paper. It has a grey to drab to dark brown pileus rather than one which is clay buff to hazel to cigar brown to almost black. The partial veil is inferior, descendent and evanescent, whilst that of *A. umbrinella* and *A. muriniflammea* is descendent, and that of *A. horizontalis* and *A. doreta* is initially patent. The spores of *A. cinereoalba* are broadly ellipsoid to ellipsoid, whilst those of *A. umbrinella* and *A. muriniflammea* are subglobose to broadly ellipsoid to ellipsoid, and those of *A. horizontalis* and *A. doreta* are ellipsoid to elongate. The spores of *A. cinereoalba* are also larger than those of the other species (*A. cinereoalba*: **L′** = 13.8 µm, **W′** = 9.8 µm; *A. umbrinella*: **L′** = 10.9 µm, **W′** = 8.8 µm; *A. muriniflammea*: **L′** = 11.6 µm, **W′** = 9.1 µm; *A. horizontalis*: **L′** = 12.7 µm, **W′** = 8.5 µm; *A. doreta*: **L′** = 12.2 µm, **W′** = 7.5 µm).

Not all collections of *A. cinereoalba* have 4-spored basidia. All basidiomes in collection AD-C60063 have 2-spored basidia, whilst those in AD-C53026 and AD-C53045 are 4-spored.

In the *tef-1* analysis, *A.* aff. *horizontalis* AD-C49442 clusters with *A. cinereoalba* with good support (BS 92) (Figure 2A); however, in the *rpb2* and concatenated analyses, *A. cinereoalba* does not cluster with the other species (Figure 2B, D).

ITS cloned haplotypes of *A. cinereoalba* show that there is considerable variation between the clones. They show 0.2–8.3% variation within an individual and 9.8–15.2% variation between collections of this species (Table 8). However, they show 21.5–26.8% variation between clones of *A. umbrinella* (Table 4), 22.1–25.9% variation between clones of *A. muriniflammea* (Table 5), 21.9–26.8% variation between clones of *A. horizontalis* (Table 6) and 23.4–26.6% variation between clones of *A. doreta* (Table 7).

On the basis of the colour of the basidiomes, the size and shape of the spores, and the phylogenetic data, *A. cinereoalba* is described as a new species.

Discussion

Species delimitation within *Amanita* is difficult; most species cannot be named solely on their macroscopic appearance. *Amanita umbrinella* is a case in point: spore amyloidy is one essential microcharacter that cannot be determined from a photograph. Within sect. *Amarrendiae* our work has shown that there are several cryptic agaricoid species that require detailed microscopic observations and sequencing to distinguish them from *A. umbrinella*. A summary is given in Table 9, which illustrates the similarities in their macroscopic appearance and spore size and shape. Their molecular sequences have provided invaluable assistance in separating them. There are other collections that need further work. Collections AD-C49442 and MEL 2432442, which we have called *A.* aff. *horizontalis* for convenience, likely represent two additional species. There is also *A.* sp. ‘albertellarum’, represented in GenBank by KX270335, which is in this section (Figure 1) but determination of its status needs macroscopic and microscopic work. Within the collections referenced by Wood (1997) there is a photograph (*J.J. Bruhl* 83/222, UNSW DB22934) of a basidiome with a cream yellow pileus and globose to subglobose spores, which was identified as *A. umbrinella*, but the colouration does not fit with that species and unfortunately DNA could not be extracted from that collection (Table 1). The Wood material was difficult to work with and so we were only able to confirm the identity of one collection as *A. umbrinella* using DNA sequencing. Similarly, we were unable to confirm the absence of clamp connections in *A. conicogrisea* because the herbarium specimen was extremely brittle.

More, well documented collections are needed to further this work on sect *Amarrendiae*.

Table 9. Comparison of some macroscopic and microscopic characters of *A. cinereoalba*, *A. doreta*, *A. horizontalis*, *A. muriniflammea*, and *A. umbrinella*. Stipe measurements are the length from the base of the pileus to the top of the bulb; width is at mid-stipe. Spore measurements (length × width) and ratio of length/width (Q) are means from collections measured.

Character	Measure	*A. cinereoalba*	*A. doreta*	*A. horizontalis*	*A. muriniflammea*	*A. umbrinella*
Pileus	Diameter (mm)	23–55	85–112	40–125	50–140	40–120
	Colour	Grey to dark brown	Clay buff to hazel	Clay buff to drab	Reddish brown to greyish brown to grey, milky coffee to hazel to drab	Buff to dark brown to grey to dark olive
Universal veil	Colour	White to milky coffee	White to pale	White to buff to drab	White to greyish	White to grey to buff
	Form	Flat patches	Initially crustose breaking into patches	Initially crustose, breaking into patches	Warts or patches	Initially crustose, breaking into patches
Stipe	Length × width (mm)	12–34 × 7–11	85–100 × 18–31	55–85 × 9–18	80–110 × 15–30	23–40 × 20–30
	Colour	White to brownish white	White	White to pale grey	White, creamy white with rosy tints	White to cream to buff
Partial veil	Colour	White to greyish white	White	White to pale drab	White, to cream to brownish grey to grey	White to grey
	Form	Descendent, evanescent	Wide to narrow, thick, horizontal	Wide, initially horizontal, thick, collapsing	Descendant, collapsing, adpressed	Wide, thick, descendent becoming adpressed
Spores	Length × width (µm)	13.0–14.5 × 8.7–10.4	12.0–12.4 × 7.2–7.8	11.8–14.7 × 7.4–10.1	10.9–12.1 × 8.1–9.4	9.4–11.5 ×. 8.1–10.0
	Q	1.36–1.50	1.55–1.73	1.32–1.75	1.16–1.43	1.12–1.36
	Shape	Ellipsoid	Ellipsoid to elongate	Ellipsoid to elongate	Broadly ellipsoid to ellipsoid	Subglobose to broadly ellipsoid to ellipsoid
	Amyloidy	Inamyloid	Inamyloid	Inamyloid	Inamyloid	Inamyloid
Clamp connections	Presence	Present	Present	Present	Present	Present

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Acacia yinnetharra (Fabaceae: Mimosoideae), a new species from the Gascoyne bioregion of Western Australia

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SHORT COMMUNICATION

Acacia yinnetharra Maslin & A.J.G.Wilson, *sp. nov.*

Type: Yinnetharra Station, Western Australia [precise locality withheld for conservation reasons], 17 October 2015, *L.S.J. Sweedman* 8968 (*holo*: PERTH 08786542! ex KPBG; *iso*: K *n.v.*, KPBG 29719!).

Acacia sp. Yinnetharra (L. Sweedman 8229), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 12 December 2024].

Trees 5–8(–12) m tall, with pendulous branchlets and phyllodes; trunks and branches somewhat crooked, the main trunk to 30 cm diam. on oldest plants. *Bark* rough and grey on main trunk(s). *Branchlets* terete, obscurely ribbed, at extremities the ribs possess a thin overburden of translucent resin (not viscid) that ages yellow and is lost on mature branchlets where the ribs are scarcely visible, glabrous except young branchlets sericeous between the ribs. *Phyllodes* terete, (7–)10–20(–30) cm long, 0.5–0.7 mm diam., slender, sub-straight to shallowly or moderately incurved or occasionally sigmoid, not rigid, finely multiveined, with veins slightly resinous (not viscid), glabrous except very young phyllodes obscurely sericeous between veins, green. *Gland* situated on upper surface of phyllode (0–)2–10(–18) mm above the indistinct yellowish pulvinus, inconspicuous, *c.* 0.5 mm long, not raised, the phyllodes sometimes very slightly to ±obviously kinked in region of gland and/or lamina slightly swollen about the gland. *Inflorescences* axillary, normally comprising 2 pedunculate spikes per node with a new shoot arising from within their axil, sometimes single at the node. *Spikes* bright yellow, 10–25 mm long; peduncle *c.* 4 mm long in flower, to 6 mm long in fruit, densely sericeous in flower but sparsely so in fruit. *Flowers* very small, readily falling apart upon dissection when dry, mostly 4-merous but also a few 5-merous in the few spikes examined; calyx minute (*c.* 0.3 mm long), dissected to *c.* 1/2 its length or almost to the base, the lobes light brown, oblong and subglabrous; petals *c.* 1.2 mm long, glabrous, with veins not visible; ovary densely white-tomentose. *Bracteoles* light brown, spathulate, minute (*c.* 0.3 mm long). *Pods* moniliform to sub-moniliform (i.e. low-domed to clearly raised over seeds and shallowly to prominently constricted between them), mostly 6–12 cm long, 6–7 mm wide (2–5 mm wide at isthmus), coriaceous, straight to shallowly curved, acute, gradually narrowed at base to stipe *c.* 5 mm long, obviously longitudinally striate by light brown slightly resinous plane veins 0.5–1.5 mm apart, anastomoses very few or absent, densely minutely silvery-white closely appressed-hairy between the veins; marginal vein light brown, not raised. *Seeds* longitudinal, obloid (and rather abruptly narrowed at hilar end) or elliptic (gradually narrowed at hilar end), somewhat compressed (*c.* 2 mm thick), 8–10 mm long, 4–5 mm wide, brown except dull yellow in centre associated with areole, not shiny; areole U-shaped to elongated U-shaped (open at hilar end), indistinct, 0.5–4 mm long, *c.* 1 mm wide at the opening; funicle ±filiform, slightly expanded into a very small aril. (Figures 1, 2)

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Figure 1. *Acacia yinnetharra*. A – plants on Yinnetharra Station adjacent to the Gascoyne River; B – population on rocky rise at Gifford Creek Station. Photographs by Luke Sweedman (A, unvouchered) and Jerome Bull (B, unvouchered).

Figure 2. *Acacia yinnetharra.* A – lush habit of plant growing on floodplain at Yinnetharra Station; B – branchlet *in situ* on Gifford Creek Station, showing pendulous, finely multistriate phyllodes slightly kinked near their base; C – branchlet of plant in cultivation at Kings Park & Botanic Garden, showing spicate inflorescences and pendulous foliage. Photographs by Luke Sweedman (A, from *L. Sweedman* 8229), Jerome Bull (B, unvouchered) and Bruce Maslin (C, from *B.R. Maslin s.n.* 1 Apr. 2022).

Distinctive features. Small trees with pendulous branchlets and phyllodes. Phyllodes long (mostly 10–20 cm), slenderly terete (0.5–0.7 mm diam.), finely multistriate. Gland mostly 2–10 mm above pulvinus, indistinct but phyllodes slightly to obviously kinked and/or slightly swollen at the gland. Inflorescences spicate. Flowers 4(5)-merous. Bracteoles minute. Pods ±moniliform, 6–12 cm long, 6–7 mm wide, longitudinally striate by brown veins, densely minutely silvery-white appressed-hairy between the veins.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 May 2023, *J.P. Bull* ONS-5251 (PERTH 09624252); 4 Aug. 2023, *J.P. Bull* ONS-5415 (PERTH 09624260); 4 Aug. 2023, *J.P. Bull* ONS-5417 (PERTH 09624198); 11 Aug. 2023, *J.P. Bull* ONS-5720 (PERTH 09624244); 11 Aug. 2023, *J.P. Bull* ONS-5722 (PERTH 09624171); 23 July 2011, *L. Sweedman & G. Brand s.n.* (PERTH 07984375); 5 Oct. 2011, *L. Sweedman* 8229 (KPBG 27804); 5 Oct. 2011, *L. Sweedman* 8229 (PERTH 08310475); cultivated in Kings Park Botanic Garden, 1 Apr. 2022, *B.R. Maslin s.n.* (PERTH 09747311); cultivated in Kings Park Botanic Garden, 2021, *M. Zhao s.n.* (PERTH 09690778).

Phenology. Due to the paucity of collections the phenology of this species in nature is poorly known. The single flowering specimen was collected in late July, at which time there were nearly mature pods also present, and a specimen with mature pods was collected in mid-October. In cultivation at Kings Park and Botanic Garden, Perth, plants have been observed at peak anthesis in early April, with immature pods in early June and mature seeds about September. It is postulated that in nature the flowering and fruiting in this species is influenced by the timing and intensity of rainfall events.

Distribution. Known only from a restricted area about 100 km east of the Kennedy Range National Park in the Gascoyne IBRA region, about 250 km due east of Carnarvon, Western Australia. It occurs in two areas within the Gascoyne River drainage system, namely Gifford Creek Station, and Yinnetharra Station approximately 90 km to the south. Collectors' labels note that the species is relatively common in the places where it has been found. For example, for Yinnetharra Station, Luke Sweedman records about 50 trees of mixed age at the type locality, while on Gifford Creek Station Jerome Bull records a frequency of 20–75 plants per hectare in a series of populations. The general region in which the species is found has been relatively poorly collected and it is therefore possible that surveys will yield additional populations. Interestingly, the Yinnietharra Rock Dragon, *Ctenophorus yinnietharra* (Storr 1981), has a similar disjunct distribution (Atlas of Living Australia 2024).

Habitat. On Yinnetharra Station the species grows in red sandy clay or on red clay pans associated with the Gascoyne River and spreading for *c.* 3–5 km into adjacent sandy country. On Gifford Creek Station it grows in silty loam associated with the Gifford Creek watercourse, on rocky (siliciclastic) plains and adjacent hills.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *A.* sp. Yinnetharra (L. Sweedman 8229).

Etymology. The species name refers to Yinnetharra Station, a cattle station in the Upper Gascoyne Shire about 250 km due east of Carnarvon, and is treated as a noun in apposition. It is noted, however, that there is some variation in the spelling of that Station name on maps and in gazetteers, where sometimes it is spelt 'Yinnietharra'. This was also the spelling adopted for the aforementioned Yinnietharra Rock Dragon. However, we have adopted the spelling 'Yinnetharra' because this is what is used on maps that we have seen, on herbarium specimen labels, on signage in Kings Park and Botanic Garden, and on *Florabase* when the species was treated as a phrase-named taxon.

Affinities. *Acacia yinnetharra* belongs to sect. *Juliflorae* (Benth.) Maiden & Betche and is most closely related to *A. atopa* Pedley. Both species have terete, finely multiveined phyllodes, spicate inflorescences, very similar flowers and bracteoles, and pods that are longitudinally striate with a dense sericeous indumentum between the veins. The two species grow in the same general region where they are broadly

parapatric, with current knowledge showing the more widespread *A. atopa* occurring to the west and south of *A. yinnetharra*, with a distribution extending from Erong Springs Station west to Pimbee Station and north to the Kennedy Range, in an arc 100–150 km from Yinnetharra Station (Western Australian Herbarium 1998–). *Acacia atopa* is most readily distinguished from the new species by its non-pendulous branches and phyllodes, and by its much smaller pods (15–40 mm long, 2–4 mm wide) that are ±quadrangular in section and not constricted between the seeds; it also has shorter phyllodes (normally 5–9 cm long) and narrower seeds (*c.* 2 mm wide). See further discussion under *Variant* below.

In the absence of pods, *A. yinnetharra* can easily be mistaken for *A. paraneura* Randell which, apart from its arborescent stature, weeping branchlets and phyllodes, and spicate inflorescences, resembles the new species in having phyllodes that are long, terete, finely multiveined and often slightly but discernibly kinked at the gland. *Acacia paraneura* is most readily distinguished from *A. yinnetharra* by its flat, winged pods that are normally 8–12 mm wide, and its generally longer peduncles (normally 5–12 mm long). The closest known occurrences of *A. paraneura* to those of *A. yinnetharra* are about 300 km to the east and northeast (Maslin & Reid 2012).

The longitudinally striate pods that are densely sericeous between the veins suggest that *A. yinnetharra* has a relationship to *A. ramulosa* W.Fitzg., a variable species comprising two varieties that are both widespread in the arid zone. This species is in need of critical review which makes it difficult to comprehensively assess its relationship to *A. yinnetharra*. However, *A. ramulosa* is normally a shrub to 6 m tall and does not have a weeping habit, its phyllodes are rigid and vary from flat (var. *ramulosa*) to terete (var. *linophylla* (W.Fitzg.) Pedley), its flowers are larger (petals to 2.5 mm long), and its pods are often wider (to *c.* 10 mm, or sometimes 15 mm).

In its pendulous habit and long phyllodes, the new species is superficially similar to *A. coriacea* subsp. *pendens* R.S.Cowan & Maslin, which is also cultivated in Kings Park and Botanic Garden. However, the two taxa are not closely related, with subsp. *pendens* belonging to sect. *Plurinerves* (Benth.) C.Moore & Betche and readily recognized by its flat, albeit narrow phyllodes (1–4 mm wide), globose heads arranged in condensed racemes, wide pods (6–13 mm) and conspicuous, bright orange seed arils.

Variant. The above description and discussion of *A. yinnetharra* does not include *G. Johnstone* 1/84 (PERTH 00346942 & PERTH 09747303), which was collected in late July 1984 from Dalgety Downs Station (specimen in flower and with slightly immature pods). In common with *A. yinnetharra* and *A. atopa* it possesses terete, finely multistriate phyllodes, spicate inflorescences and small flowers. It resembles *A. yinnetharra* in its long phyllodes (to 20 cm) and is described by the collector as having a pendulous habit, however, it possesses the distinctive, very short, quadrangular pods of *A. atopa.* While further field and laboratory studies are needed to understand this variation, it is known that the weeping habit occurs sporadically in a few other species of sect. *Juliflorae* that usually have an upright habit, e.g. *A. acuminata* Benth. and *A. papyrocarpa* Benth.

This variant was collected *c.* 40 km east of where *A. yinnetharra* occurs on Yinnetharra Station, and *c.* 100 km to the north and northeast of the closest known collections of *A. atopa* on Erong Springs Station and Dairy Creek Station respectively.

Notes. This species was discovered in July 2011 by Luke Sweedman and Grady Brand, both then employed by Kings Park and Botanic Garden, Perth. The species has been successfully cultivated in Kings Park where it forms a small tree which is very attractive on account of its long, pendulous and slenderly terete phyllodes.

Acknowledgements

Luke Sweedman and Grady Brand are acknowledged for first discovering this species (on Yinnetharra Station) and are thanked for bringing it to our attention, providing information and field photographs,

and introducing it into cultivation at Kings Park and Botanic Garden (KPBG). We also thank Jerome Bull who subsequently discovered multiple populations from Gifford Creek Station and provided us with detailed-labelled specimens and photographs, some of which he has generously permitted us to use in this publication. We also extend our thanks to Myriam Everall, Peter Nguyen and Jessica Glover from KPBG, who facilitated our collection and observation of the new species under cultivation. Kelly Shepherd is gratefully acknowledged for compiling the figures.

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Brachyloma brevilobum and *Conostephium interstans*, two new epacrids (Ericaceae: Epacridoideae: Styphelieae) from remote areas of the central south coast of Western Australia

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SHORT COMMUNICATION

Brachyloma brevilobum Hislop, *sp. nov.*

Type: north-west of Condingup, Western Australia [precise locality withheld for conservation reasons], 8 June 2024, *K. Walkerden* KSW 576 (*holo*: PERTH 09770704; *iso*: CANB, CNS, HO, K, MEL, NSW).

Erect *shrubs* to *c.* 1.6 m high and 1.2(2) m wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* with a very short, sparse indumentum of hairs < 0.05 mm long. *Leaves* helically arranged, variably antrorse (mostly steeply so); apex acute or occasionally subacute, with a blunt callus tip; base cuneate to rounded; petiole well-defined, 0.8–1.7 mm long, glabrous throughout or with a few hairs on the adaxial surface; lamina ovate to narrowly ovate or elliptic to narrowly elliptic, 4.0–7.0 mm long, 1.8–3.0 mm wide, concolorous, concave adaxially, longitudinal axis gently incurved; adaxial surface slightly shiny, glabrous, without evident venation; abaxial surface matt throughout or slightly shiny on vein surfaces, glabrous, with 5–7 primary veins, openly and shallowly grooved between the veins; margins glabrous or with very short, coarse, antrorse hairs < 0.05 mm long. *Inflorescence* axillary, erect; axis 0.9–1.5 mm long, 1- or 2-flowered, with a moderately dense indumentum, ± terete, terminating in a bud-rudiment; flowers erect, sessile. *Fertile bracts* depressed-ovate or broadly ovate, 0.5–0.7 mm long, 0.6–0.8 mm wide, with 2–4 sterile bracts on the axis below. *Bracteoles* depressed-ovate or broadly ovate, 0.5–0.8 mm long, 0.7–1.0 mm wide, obscurely keeled, obtuse; abaxial surface glabrous or occasionally with a few hairs about the keel, not striate; margins ciliolate. *Sepals* broadly ovate, 1.2–1.5 mm long, 0.9–1.0 mm wide, obtuse or occasionally subacute; abaxial surface glabrous, pale green, becoming whitish towards the margins, with obscure venation; margins ciliolate with hairs to 0.1 mm long. *Corolla tube* white, ovoid to ellipsoid or narrowly so, distinctly longer than the sepals, 1.5–2.0 mm long, 1.2–1.5 mm wide, external and internal surfaces glabrous. *Corolla lobes* white, thick, narrowly triangular, shorter than the tube, 1.0–1.5 mm long, 0.5–0.6 mm wide, spreading from the base and recurved, often with inflexed tips, external surface glabrous, internal surface keeled and strongly papillate throughout (except sometimes for the inflexed tips) with a narrow zone of conspicuous retrorse hairs arising from the base and projected into the upper tube. *Anthers* partially exserted from the tube (by up to 1/4 of their length), 0.7–0.9 mm long, the lateral surfaces papillose, apex shortly emarginate. *Filaments* terete, *c.* 0.1 mm long, attached to anther just below the apex, adnate to the tube just below the sinuses. *Nectary* annular, 0.3–0.5 mm long, lobed for up to 1/3 of its length, glabrous. *Ovary* globose or broadly obovoid, 0.5–0.7 mm long, 0.5–0.7 mm wide, glabrous, 2(3)-locular, very pale green or almost white. *Style* 0.3–0.4 mm long, minutely scabrous, well-differentiated from ovary apex; stigma not or scarcely expanded. *Fruit* depressed-globose, usually slightly compressed laterally and elliptic in transverse section or obscurely trigonous if 3-locular, 1.6–1.8 mm long, 2.2–2.5 mm wide, much longer

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than the sepals; gynophore absent; surface glabrous, ± rugose; apex ± truncate with rounded shoulders; style retained at maturity. (Figure 1)

Diagnostic characters. Distinguished by the following combination of characters: flowers white; corolla lobes short, narrowly triangular, often with inflexed tips, 1.0–1.5 mm long, 0.5–0.6 mm wide, shorter than the tube and strongly papillate throughout, except sometimes for the inflexed tips; ovary 2(3)-locular; fruit depressed-globose, usually slightly compressed laterally and elliptic in transverse section.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 Mar. 2024, *K. Walkerden* KSW 546 (PERTH); 29 Mar. 2024, *K. Walkerden* KSW 542 (PERTH); 29 Mar. 2024, *K. Walkerden* KSW 543 (CANB, CNS, MEL); 8 June 2024, *K. Walkerden* KSW 570 (NSW, PERTH); 8 June 2024, *K. Walkerden* KSW 572 (K, PERTH); 8 June 2024, *K. Walkerden* KSW 573 (PERTH); 8 June 2024, *K. Walkerden* KSW 575 (CANB, PERTH); 16 June 2024, *K. Walkerden* KSW 582 (CNS, PERTH); 16 June 2024, *K. Walkerden* KSW 585 (MEL, PERTH).

Distribution and habitat. Currently known from a small area north-east of Esperance. Grows in sandy soils, sometimes in subsaline sites, in the understorey of mallee woodland. Associated species include *Eucalyptus pleurocarpa, Banksia media, Melaleuca pulchella, M. hnatiukii, Hakea cinerea, Phymatocarpus maxwellii* and *Grevillea oligantha*.

Phenology. Has an extended flowering period, at least between March and July. Fruit can similarly be expected to be present over many months of the year and has so far been recorded in March and June.

Etymology. From the Latin *brevis* (short) and *lobus* (a lobe), a reference to the short corolla lobes relative to those of the otherwise similar *B. stenolobum* Hislop & Cranfield.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). On the basis of current knowledge, this species is restricted to a small, remote area of Unallocated Crown Land north-east of Esperance, where the plant is often locally common. Since this area lies close to a large nature reserve, there is a strong likelihood that it also occurs

Figure 1. *Brachyloma brevilobum*. A – flowering plant *in situ*; B – flowering branchlet *in situ*. Voucher *K.S. Walkerden* KSW 584. Photograph by Katherine Walkerden.

within the boundaries of that reserve. In addition, extensive tracts of similar country lie to the north of its known distribution.

Affinities. *Brachyloma brevilobum* is similar in gross morphology to *B. stenolobum*, differing in the detail of its corolla and gynoecium. In *B. brevilobum*, the corolla lobes are shorter than the tube, 1.0–1.5 mm long, often with inflexed tips, and have papillae that extend along their full length, except sometimes for the inflexed tips. In contrast, *B. stenolobum* has lobes longer than the tube, never with inflexed tips, 2.1–2.7 mm long and with the distal third ± smooth (Figure 2). The corolla tubes of *B. brevilobum* are also longer than those of *B. stenolobum* (1.5–2.0 mm long *cf.* 1.2–1.6 mm), and the tube is distinctly exserted beyond the sepal apices, whereas in *B. stenolobum* the tubes are barely longer than the sepals. This leads to the characteristic appearance of the flower buds of *B. stenolobum* which taper gradually from the sepal apices to the bud tip. By comparison, the buds of *B. brevilobum* taper more abruptly from a point well

Figure 2. *Brachyloma stenolobum*. Flowering plant *in situ.* Voucher *M. Hislop & F. Hort* MH 2592. Photograph by Michael Hislop.

above the sepal apex. Whereas *B. brevifolium* usually has a 2-locular (occasionally 3-locular) ovary and a mature fruit that is depressed-globose and slightly compressed laterally, *B. stenolobum* has a mostly 3-locular (occasionally 2- or 4-locular) ovary and a fruit that is globose and circular in transverse section.

Although the foliar characters of the two species are generally very similar, the leaves of *B. brevilobum* tend to be larger (4.0–7.5 mm long and 1.8–3.0 mm wide *cf.* 3.0–4.8 mm long and 1.3–2.0 mm wide in *B. stenolobum*). There is also partial difference in shape, with *B. brevilobum* having either ovate or elliptic leaves and *B. stenolobum* having always elliptic leaves.

Identification. In order to accommodate the new species, the most recent key to the Western Australian species of *Brachyloma* (Hislop & Cranfield 2017: 305–306) requires modification to insert an extra couplet 2A as follows:

1. Corolla red or white; lobes narrowly triangular, acute, adaxially keeled in the upper half, strongly papillate or shortly hairy, at least about the keel (sect. Lissanthoides)

2. Corolla red; tube > 10 mm long; 5 hairy appendages inserted close to the base of the corolla tube (Lake Muir–Fitzgerald River)..... **B. baxteri**

2: Corolla white; tube to 1.7 mm long; appendages lacking from the corolla tube, 5 hair tufts reflexed into the tube from the lobe bases

2A. Corolla lobes longer than the tube, 2.1–2.7 mm long, ± smooth in the upper 1/3, strongly papillate in the lower 2/3, never with inflexed tips; ovary mostly 3- or occasionally 2- or 4-locular; fruit globose, circular in transverse section(Forrestania area; Bremer Range area)..... **B. stenolobum**

2A: Corolla lobes shorter than the tube, 1.0–1.5 mm long, strongly papillate throughout, often with inflexed tips; vary 2- or occasionally 3-locular; fruit depressed-globose, usually slightly compressed laterally and elliptic in transverse section (NE of Esperance).... **B. brevilobum**

Conostephium interstans Hislop, *sp. nov.*

Type: north-west of Cascade, Western Australia [precise locality withheld for conservation reasons], 15 August 2015, *W. Archer* 1508151 (*holo*: PERTH 08894523; *iso*: CANB, K, MEL, NSW).

Erect *shrubs* to *c.* 1.2 m high; fire-tolerance of rootstock unknown. Young *branchlets* with a sparse indumentum of very short hairs, < 0.05 mm long or ± glabrescent. *Leaves* helically arranged, glaucous, variably antrorse (usually steeply so); apex shortly mucronate, the mucro innocuous, 0.2–0.4 mm long; base cuneate to rounded; petiole well-defined, 0.5–0.8 mm long, usually with a few hairs on the adaxial surface and margins or ± glabrescent throughout; lamina narrowly obovate, narrowly obtriangular, narrowly elliptic or sometimes linear, 6–11 mm long, 0.9–2.6 mm wide, adaxially convex, margins slightly recurved to strongly revolute, longitudinal axis straight to gently incurved; adaxial surface glabrous, faintly verrucose, without evident venation; abaxial surface slightly paler, with 5–7 raised primary veins, ± closed to openly grooved between the veins, the midrib not differentiated from the rest, glabrous throughout or with sparse short hairs in the grooves; margins glabrous or with stiff antrorse hairs to *c.* 0.05 mm long. *Inflorescence* pendulous or sub-pendulous; axis 1.5–2.3 mm long, hairy, in large part obscured by imbricate bracts. *Axis bracts* 7–8(10), depressed-ovate to broadly ovate, the 2 uppermost 1.2–2.0 mm long and 1.4–2.0 mm wide. *Floral bracts* 4–5, broadly ovate, 2.0–3.5 mm long, 1.8–2.8 mm wide, obtuse, obscurely mucronate. *Bracteoles* ovate to elliptic, 3.2–4.6 mm long, 2.4–3.0 mm wide, obtuse, obscurely mucronate; abaxial surface glabrous, greenish cream, usually with brownish or reddish tinges in the distal half, multi-veined and faintly striate in the distal half; margins minutely ciliolate. *Sepals* ovate to narrowly ovate, 4.2–6.2 mm long, 2.2–3.1 mm wide, the outer obtuse to subacute, the inner subacute to acute; abaxial surface glabrous, mostly straw-coloured, with brownish or reddish tinges towards the apex, multi-veined and faintly striate in the distal half; margins ± glabrous or minutely ciliolate mostly about the apex with hairs < 0.05 mm long. *Corolla* shed soon after anthesis. *Corolla tube* zygomorphic, essentially fusiform, with the widest part (the bulge) at the middle, 7.0–9.0 mm long, 2.9–3.3 mm wide, with the exposed portion dark purple 0.3–0.5 mm immediately below the lobes; external surface glabrous;

internal surface moderately hairy from the orifice to the base of the bulge with both antrorse and retrorse hairs, glabrous below the bulge. *Corolla lobes* erect to ± spreading, pale, 0.2–0.5 mm long, 0.2–0.3 mm wide at base, glabrous throughout. *Anthers* 3.4–4.2 mm long, the lobes comprising 1/3–1/2 the length of the anthers. *Filaments* 1.0–1.3 mm long, 0.4–0.5 mm wide, glabrous, flattened, adnate to the tube at *c.* the middle; connective dark brown, abruptly and prominently thickened, attached a little below 1/2 above anther base. *Nectary* annular, 0.1–0.2 mm long. *Ovary* ovoid, 1.0–1.4 mm long, 0.8–1.0 mm wide, glabrous, 4- or 5-locular. *Style* 7.0–9.5 mm long, glabrous. *Fruit* broadly ovoid, 4.0–5.0 mm long, 4.0–4.5 mm wide; apex obtuse to subacute; surface rugose; endocarp ± smooth. (Figure 3B)

Diagnostic characters. Distinguished by the following combination of characters: leaves adaxially convex, 6–11 mm long, the margins slightly recurved to strongly revolute, the mucros 0.2–0.4 mm long and innocuous; inflorescence axes 1.5–2.3 mm long; corolla shed after anthesis; exposed portion of corolla tube dark purple, smooth, narrowly attenuate below the lobes; corolla lobes 0.2–0.5 mm long, 0.2–0.3 mm wide; anther connectives prominently thickened, dark brown; endocarp ± smooth.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 15 Aug. 2015, *W. Archer* 1508152 (PERTH); 16 Aug. 2015, *W. Archer* 1608152 (PERTH); 8 Nov. 2015, *W. Archer* 811151 (PERTH); 9 Nov. 2015, *W. Archer* 911151 (CANB, PERTH); 11 Aug. 2024, *K. Walkerden* KSW 642 (CANB, K, PERTH); 11 Aug. 2024, *K. Walkerden* KSW 643 (PERTH); 11 Aug. 2024, *K. Walkerden* KSW 645 (CNS, NSW, PERTH).

Distribution and habitat. Known from a remote area in the district of North Cascade in the Mallee bioregion, where it grows in deep sand in the understorey of open mallee woodland. Associated species

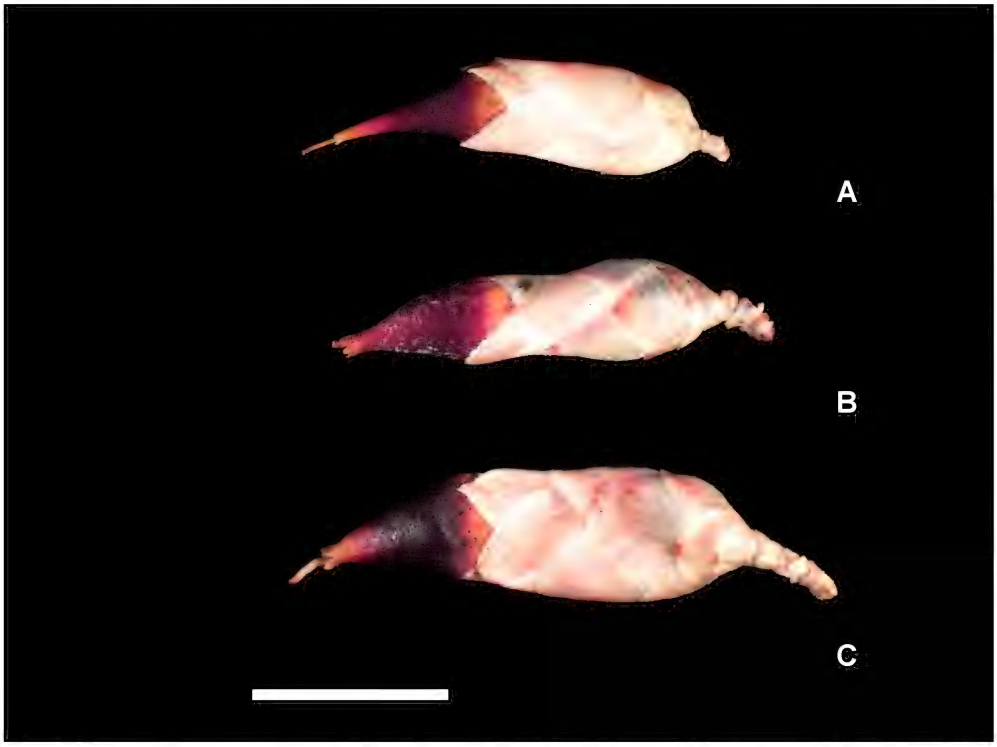

Figure 3. Scanned images of *Conostephium* inflorescences. A – *C. roei*; B – *C. interstans*; C – *C. prolatum*. Scale bar = 5 mm. Vouchers *M. Hislop* 4483 (A), *W. Archer* 1508152 (B), *M. Hislop* 4154 (C).

include *Eucalyptus pleurocarpa*, *Banksia media*, *Phymatocarpus maxwellii*, *Beaufortia micrantha* and *Callitris preissii*.

Phenology. All flowering collections have been made in August with the plants at about mid-flowering stage, which suggests that the main flowering period is between July and September. Mature fruit has been collected in November.

Etymology. From the Latin *inter* (between) and *stans* (standing), a reference to some aspects of the morphology of the new species that are somewhat intermediate between *C. roei* Benth. and *C. prolatum* Hislop.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens, pers. comm.). The species is currently known from two localities about 12 kilometres apart, both on Unallocated Crown Land. Label information suggests that at least at one site it is locally common. The general area is quite inaccessible and poorly known botanically and there is a likelihood that further survey will show that the plant is more widely distributed than current records suggest.

Affinities. *Conostephium interstans* is most likely to be confused with either *C. roei* or *C. prolatum*. The three species have allopatric distributions, with *C. interstans* occurring in the Lake Tay area, north-west of Cascade, *C. roei* between Ongerup, Newdegate and Lake Magenta, and *C. prolatum* in the south of the Fitzgerald River National Park.

Conostephium roei can be distinguished from the other two species, and indeed all other members of the genus by its deeply ridged fruiting endocarp. This feature is very unusual in the western *Styphelieae*, but another example can be found in *Acrotriche patula* R.Br. (see Hislop 2007: 288–291), which is also the only species among the western members of that genus with a ridged endocarp.

The floral morphology of *C. interstans* is close to that of *C. roei*, with a couple of differences in the upper corolla being the best means of distinguishing between them. Although in both species the corolla tube is relatively narrow below the lobes, in *C. interstans* the upper tube tends to be less strongly zygomorphic and the tapering to lobe bases less gradual (Figure 3A, 3B).

The closest relative of *C. interstans* seems likely to be *C. prolatum* based on overall similarity. The two differ in leaf and inflorescence axis measurements and in the detail of the upper corolla. In *C. interstans*, the leaves are 6–11 mm long and 0.9–2.6 mm wide with an innocuous mucro 0.2–0.4 mm long, while in *C. prolatum* they are 10–22 mm long and 1.8–4.2 mm wide with a coarsely pungent mucro 0.5–1.0 mm long. *Conostephium interstans* has inflorescence axes 1.5–2.3 mm long whereas they are 2.3–3.1 mm in *C. prolatum*. The noticeably narrower upper corolla tube and lobes are another point of difference. In *C. interstans* the upper tube immediately below the lobes is 0.3–0.5 mm wide, and the lobes themselves are 0.3–0.5 mm long by 0.2–0.3 mm wide. This compares with a tube width of 0.5–0.8 mm and lobe dimensions of 0.4–0.6 mm by 0.3–0.4 mm for *C. prolatum* (Figure 3C).

Identification. In order to update the key to species of *Conostephium* (Hislop 2013: 316–318) by the inclusion of *C. interstans*, in addition to the recently described *C. wonganense* Hislop (Hislop 2022: 205–209), modifications are required from the second lead at couplet 11 as follows:

11: Internal corolla tube lacking hair tufts; inflorescence axis to 5.2 mm long, usually <5 mm

12. Branchlet indumentum of mixed lengths, the longer hairs 0.5–1.2 mm long; leaves linear, very narrowly triangular or very narrowly elliptic; sepals 6.1–10.8 mm long; corolla lobes 0.4–2.4 mm long

13. Internal corolla tube densely hairy from the base of the lobes to a point adjacent to the top of the ovary, the hairs coalescing into ± well-defined longitudinal bands below the base of the bulge; inflorescence axis 2.2–3.0 mm long; sepals 6.1–8.4 mm long; corolla lobes 0.4–1.0 mm long; anthers 3.0–4.1 mm long (Wongan Hills area) ..... **C. wonganense**

13: Internal corolla tube densely hairy from the base of the lobes to the base of the bulge, usually glabrous below the bulge or occasionally with sparse hairs extending to a point *c.* halfway between the bulge and the top of the ovary; inflorescence axis 2.8–5.2 mm ong; sepals 8.5–10.8 mm long; corolla lobes 1.2–2.4 mm long; anthers 3.8–5.6 mm long (eastern Darling Range)..... **C. hortiorum**

12: Branchlet indumentum very short, uniform in length, to *c.* 0.1 mm long; leaves obovate, narrowly obovate, narrowly obtriangular, narrowly elliptic or sometimes linear; sepals 3.9–7.5 mm long; corolla lobes 0.2–0.6 mm long

14. Leaves 10–22 mm long; leaf mucros 0.5–1.0 mm long, coarsely pungent; inflorescence axis 2.3–3.1 mm long; upper corolla tube immediately below the lobes 0.5–0.8 mm wide, corolla lobe width 0.3–0.4 mm wide (southern Fitzgerald River N.P.)..... **C. prolatum**

14: Leaves 4.5–11 mm long; leaf mucros 0.2–0.4 mm long, innocuous; inflorescence axis 0.9–2.3 mm long; upper corolla tube immediately below the lobes 0.3–0.5 mm wide, corolla lobe width 0.2–0.3 mm wide

15. Fruiting endocarp deeply ridged; corolla tapering gradually to lobe bases (Ongerup–Newdegate–Lake Magenta area)..... **C. roei**

15: Fruiting endocarp ± smooth; corolla tapering more steeply to lobe bases (NW of Cascade)... **C. interstans**

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Severing the first head of the Hydra: *Drosera actinioides*, a new species from the *D. paradoxa* complex of *D.* sect. *Lasiocephala* (Droseraceae)

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Abstract

Juve, N.O., Fleischmann, A. & Krueger, T. Severing the first head of the Hydra: *Drosera actinioides*, a new species from the *D. paradoxa* complex of *D.* sect. *Lasiocephala* (Droseraceae). *Nuytsia* 36: 75–84 (2025). *Drosera actinioides* Juve, A.Fleischm. & T.Krueger, a new species of *D.* sect. *Lasiocephala* Planch. from the Northern Kimberley bioregion (Western Australia), is described and illustrated. It can be distinguished from all known members of this section by its distinctive floral features comprising highly branched, blackish red styles and metallic orange petals, among other characters. Detailed notes on its ecology, distribution, and conservation status are provided.

Introduction

Drosera L. sect. *Lasiocephala* Planch. (Droseraceae), commonly known as woolly sundews or colloquially as the '*D. petiolaris* complex', was established by Planchon (1848) to circumscribe the only two species previously recognised as belonging to this affinity: *D. petiolaris* R.Br. ex DC. (the type species of the section) and *D. fulva* Planch. Molecular phylogenetic reconstructions reveal *D.* sect. *Lasiocephala* as sister to the Western Australian pygmy sundew lineage of *D.* sect. *Bryastrum* Planch. (Rivadavia *et al.* 2012; Fleischmann *et al.* 2018). Both sections are today placed in the Australian evolutionary clade *D.* subgenus *Ergaleium* (DC.) Drude following the infrageneric classification of Fleischmann *et al.* (2018).

Drosera sect. *Lasiocephala* currently comprises 16 species of perennial or annual carnivorous herbs that primarily occur in tropical northern Australia (Lowrie *et al.* 2017). However, the distribution of *D. petiolaris* extends from northern Queensland into adjacent southern coastal New Guinea while *D. banksii* R.Br. ex DC. is known from tropical northern Australia, New Guinea, and an isolated, disjunct occurrence in the Philippines (Lowrie 2014; Robinson 2017). *Drosera* sect. *Lasiocephala* is characterised by long-petiolate leaves that typically form a compact or open rosette, a distinctive and often seasonally influenced petiole indumentum comprising varying densities of white hair, ± orbicular laminae, flower scapes with a woolly indumentum (in most species), and a lack of floral bracts (Lowrie *et al.* 2017). Half of the known species were described by the late Allen Lowrie in the 1990s (Lowrie 1994, 1996a, 1996b, 1997, 1998), including the taxonomically difficult *D. paradoxa* Lowrie, an intricate stem-forming species with a terminal, subglobose rosette and short-pedicellate (often almost sessile) flowers bearing few-branched styles. Among several undescribed taxa known to the authors within *D.* sect. *Lasiocephala* are two that exhibit morphological similarity to *D. paradoxa* and are currently encompassed within the concept of that species in Lowrie (2014), Lowrie *et al.* (2017), and Nunn and Lowrie (2021). In the present work, these two undescribed taxa are informally referred to as *D. paradoxa* 'orange flowered form' and *D. paradoxa* 'swamp form'. The entire group—comprising *D. paradoxa s. str.*, the two aforementioned undescribed taxa, and additional, morphologically similar, undescribed taxa—is collectively referred to herein as the '*D. paradoxa* complex' or *D. paradoxa s. lat.* During herbarium studies and field work for an

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ongoing revision of this complex, we discovered an orange-flowered taxon with dark, heavily branched styles, and disproportionally tall inflorescences. This distinctive character combination is not known to occur in other taxa in the complex or any other members of the genus.

The single known herbarium gathering of this new taxon, housed at the Western Australian Herbarium (PERTH), was made on 16 May 1981 by the late Herbert Demarz, a German-born entomologist, seed collector, and curator of the Western Australian Seed Technology Centre at Kings Park Botanic Garden from 1970–1990 (Sweedman 2007; Barrett & Barrett 2015: 47). Recent targeted fieldwork led to the rediscovery of this taxon, which is herein formally described and illustrated as a species new to science.

Methods

The description was prepared from examination of the type material housed at PERTH and *in situ* observations made at five locations in the Northern Kimberley bioregion during the early dry season of May 2024. In the absence of a collecting permit, voucher specimens could not be obtained; however, precise locality data has been provided to the Western Australian Department of Biodiversity, Conservation and Attractions. Herbarium specimens of *D. paradoxa s. lat.* were studied for comparison, with measurements taken from material at DNA, K, L, NY, and PERTH (herbarium acronyms follow Thiers (2008–)) as well as plants studied *in situ* at numerous localities in northern Western Australia and the Northern Territory from 2014 to 2024. The distribution map was prepared using DIVA-GIS (Hijmans *et al.* 2012) and edited in Adobe Photoshop 6.0 (Adobe, USA).

Taxonomy

Drosera actinioides Juve, A.Fleischm. & T.Krueger, *sp. nov.*

Type: N of Kalumburu Mission, Western Australia [precise locality withheld for conservation reasons], 16 May 1981, *H. Demarz* 8887 (*holo*: PERTH 05863104!).

Annual herb or possibly a facultatively short-lived *perennial*, (16–)29–54 cm tall including inflorescence. *Roots* predominantly adventitious, sparse, simple, terete, blackish brown, slightly fleshy at initial development, sparsely branching and becoming wiry with age, persistent. *Stem* short and column-like, erect, self-supporting, rarely becoming prostrate with full weight of inflorescence(s) by end of wet season and at senescence, terete, unbranched, 1.0–2.5 cm long, *c.* 1–2 mm diam.; internodes usually very short, largely invisible beneath spent leaves and stipules, lengthiest during middle of wet season with new internodes becoming increasingly compressed towards anthesis. *Leaves* in an apical, semi-globose rosette, erect to horizontal, persistent but becoming strongly reflexed during senescence (contacting ground at *c.* 45°), 8.5–24.0(–40.5) mm long during wet season, 2.0–7.7 mm long during dry season, stipulate; stipule prominent, adnate to adaxial side of petiole base, often subequal to petiole of shorter dry season leaves, papery, membranous, stiff (bristle-like when dry), 3-laciniate to *c.* 80% of its length, narrowly rectangular in outline, translucent-white, 3–5 mm long, *c.* 0.5 mm wide, lateral margins irregularly serrulate near base; stipule segments slightly diverging, linear to very narrowly triangular and further divided into 2 or 3 long, fimbriate setae with minutely denticulate lateral margins; petiole linear, slightly arcuate abaxially (curved downwards), transversely elliptic in cross-section with the abaxial side shallowly domed, greyish green, turning yellowish green towards lamina, 7.0–24.0(–38.3) mm long during wet season, 1.7–6.5 mm long during dry season post-anthesis, 0.3–0.6 mm wide, tapering to 0.1–0.3 mm towards lamina; wet season petiole adaxially and abaxially very sparsely covered with appressed, antrorse, simple, terete, minutely denticulate, translucent-white hairs to 1.6 mm long; dry season petiole adaxially and abaxially densely covered with appressed, antrorse, simple (occasionally sparsely ramified), terete, minutely denticulate, translucent-white hairs to 0.9 mm long and often obscuring the epidermis so that the petiole appears greyish green, increasing in length (but also decreasing in density) towards lamina; lamina ± orbicular, yellow to orange (rarely tinged reddish pink), 1.2–2.1 × 1.1–1.8 mm during wet season, 0.6–1.3 × 0.5–1.1 mm during dry season, adaxial surface covered with stalked, carnivorous secretive capitate glands (tentacles);

tentacle stalks translucent, to 1.9 mm long at lamina margin, 0.1–1.5 mm long on inner lamina surface (gradually increasing in length towards margin); tentacle gland heads radially symmetric, pink to red, *c.* 0.1 mm long; lamina abaxial surface covered with same type of hair as on petiole. *Inflorescences* 1(–3), each forming a (10–)25–69-flowered, ebracteate, one-sided scorpioid cyme; peduncle terete, ascending but often descending up to 5 mm below the peduncle insertion before curving strongly upwards, yellowish green to reddish but turning brown or blackish brown with age, 13–26 cm long, (0.5–)0.7–1.6 mm diam. near base, subglabrous to sparsely covered with antrorse, translucent-white, minutely denticulate hairs basally, hair density and length steadily increasing distally; rachis 11–31 cm long, 0.2–0.8 mm diam.; rachis, pedicels, and calyx with a dense woolly indumentum of appressed, antrorse, simple (occasionally sparsely branched), terete, shallowly curled, translucent-white (occasionally drying yellowish brown) hairs and a few patent hairs up to 2 mm long, hair density and length increasing distally; pedicels terete, linear and erect at anthesis, strongly arcuate and pendulous in fruit, 1.0–2.6 mm long, 0.1–0.4 mm diam., spaced by 2–11 mm (reducing towards apex of inflorescence). *Flowers* 14.5–19.0 mm diam. *Sepals* 5, ovate to elliptic, basally adnate, 3.0–5.3 × 0.8–2.7 mm at anthesis, elongating to 6.4 mm post-anthesis, persistent and clasping or patent in fruit; apex acute or obtuse, shallowly truncate to irregularly crenulate; lateral margins entire; abaxial surface with a dense woolly indumentum of translucent white hairs 0.9–1.2 mm long (as per rachis and pedicels). *Petals* 5, metallic orange, obovate to broadly obovate, 5.5–9.0 mm long, 5.0–6.0 mm wide, usually with truncate apex, apical margin entire to slightly crenulate and occasionally scarcely involute; petal midvein prominent in basal 1/3–1/2 of petal, pale orange to whitish with red to dark orange margins, *c.* 0.3 mm wide at widest point, tapering distally. *Stamens* 5, 2.0–2.8 mm long; filaments linear, slightly dilated towards anthers, elliptic in cross-section, bright orange, 1.3–2.2 mm long, 0.3–0.4 mm wide, widening to 0.5 mm near apex; apex of the connective obtuse to acute, not exceeding the thecae; anthers bithecate, *c.* 0.5–0.6 mm long, 0.5–0.7 mm wide, yellow; pollen yellow. *Ovary* with 3 fused carpels, globose, usually shallowly 3-lobed in outline, dark red to blackish red, 1.0–1.3 mm diam., glabrous. *Styles* 3, divided ± dichotomously multiple times into (11–)15–18 terete arms, dark red, (<1.0–)1.0–1.3 mm long (including stigmatic part), glabrous; stigmas (33–)45–66, cylindrical with an obtuse apex, dark red to blackish red (often marginally darker than ovary and style arms), 0.45–0.60 mm long, 0.10–0.15 mm diam., stigmatic surface microscopically papillate. *Seeds* numerous, broadly ellipsoidal, 270–360 µm long, 190–240 µm wide, black with slight iridescence of the periclinal walls; testa longitudinally reticulate, anticlinal walls thin and shallow, periclinal walls tabular and minutely rugose. (Figures 1, 2; 3A, E, I)

Diagnostic features. *Drosera actinioides* can be readily distinguished from all known members of the genus *Drosera* by its combination of metallic orange petals, blackish red styles that are highly branched into (33–)45–66 segments, and a (16–)29–54 cm tall inflorescence.

Phenology. Flowering has been recorded during May but likely extends from March to June based on the phenology of individuals studied *in situ*. Seed is likely to be shed during the dry season from April to July.

Distribution and habitat. Known from an area bordering Napier Broome Bay between north of Kalumburu and Cape Talbot, in the Northern Kimberley bioregion of Western Australia (Figure 4). Colonises skeletal sandy or lateritic soils with underlying sandstone, growing in open *Eucalyptus* woodland amongst *Triodia* and other grasses (Figure 2J). Frequently associated with *Byblis filifolia*, *Xyris*, and other species of *Drosera* sect. *Lasiocephala* (*D. dilatatopetiolaris* and *D. ordensis*).

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (T. Llorens pers. comm.). Data Deficient (DD) according to IUCN criteria (IUCN Standards and Petitions Committee 2024). Known from six locations in an area *c.* 40 km long. None of these locations occur on land managed by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA). Based on satellite imagery (Figure 4), suitable nearby sandstone habitat close to the coast may also occur to the south and west of Napier Broome Bay, and possibly to the east of the Drysdale River, although further surveys are required to confirm the species' presence in those areas. Bauxite mining represents a plausible threat to this species given several mining tenements exist around Kalumburu, including one on the south-western side of Napier Broome Bay that likely comprises suitable habitat for

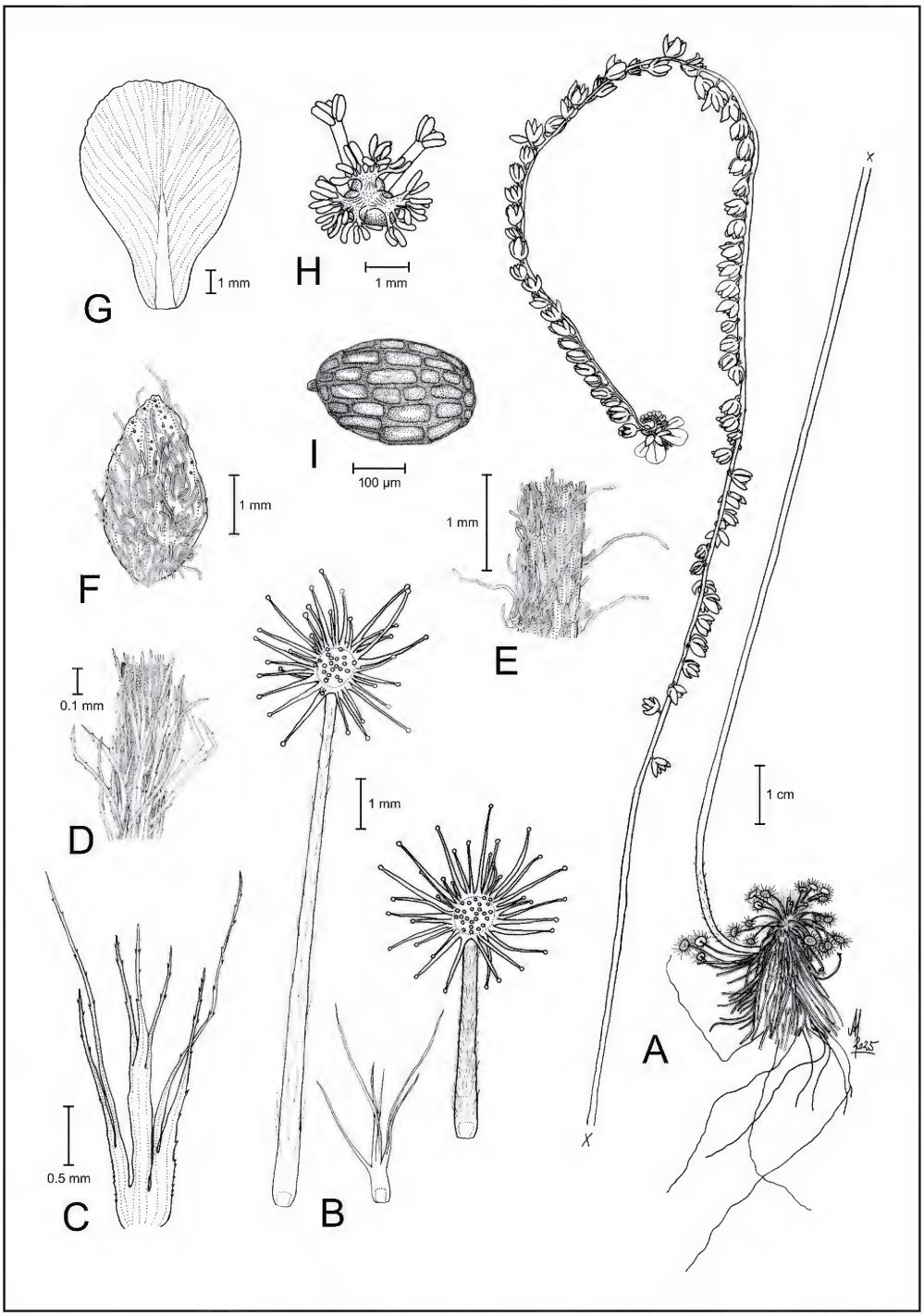

Figure 1. *Drosera actinioides*. A – habit (inflorescence indumentum not depicted); B – a detached stipule flanked by a long, wet season leaf (left) and shorter dry season leaf (right); C – stipule; D – petiole indumentum; E – peduncle indumentum; F – sepal; G – petal; H – ovary with styles and two adjacent stamens (the other three stamens not shown); I – seed. Illustration by A. Fleischmann from macro photographs of *H. Demarz* 8887 (A, C–F, I) and *in situ* photographs (B, G, H).

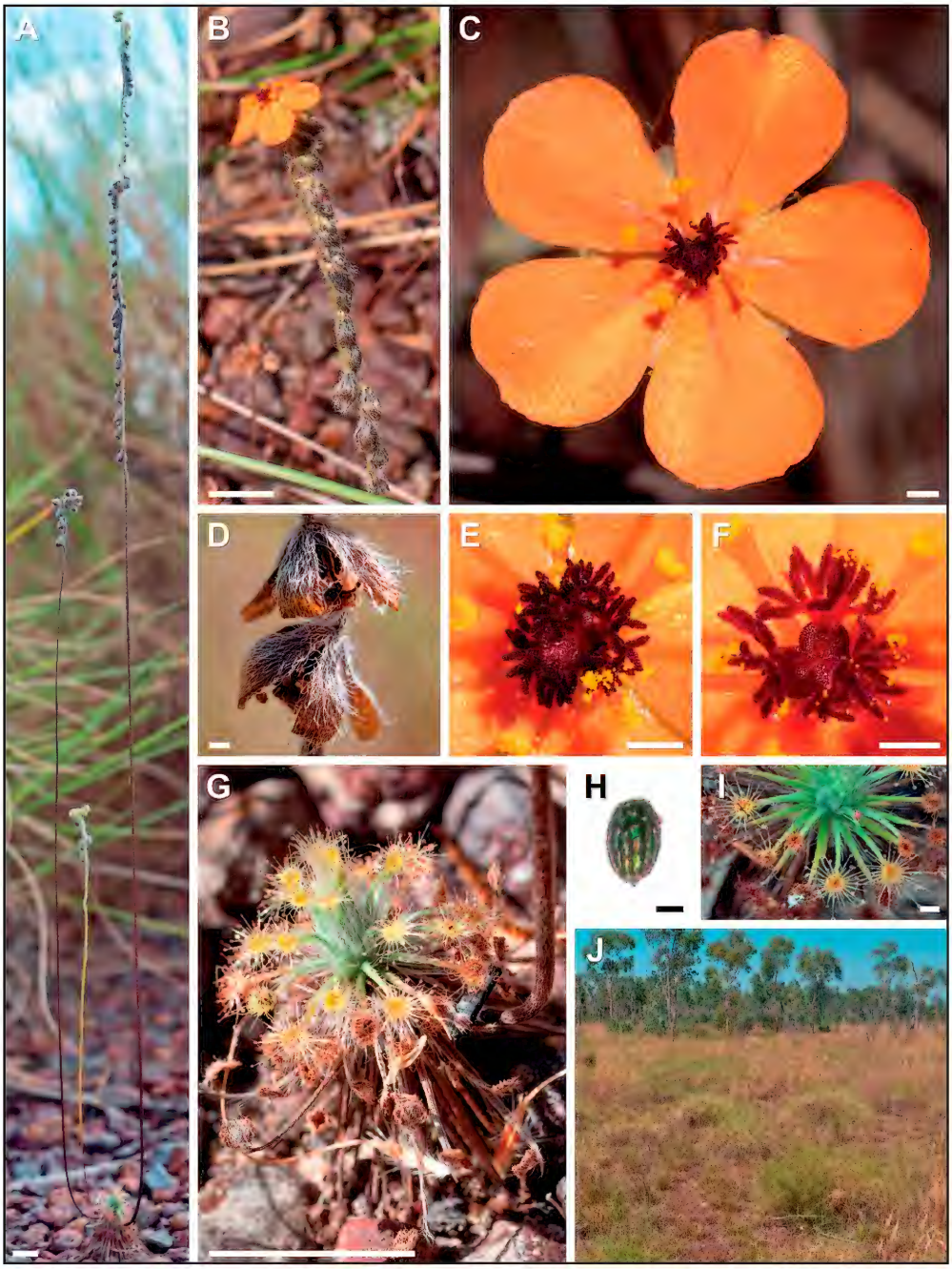

Figure 2. *Drosera actinioides*. A – flowering plant *in situ*, note the disproportionately tall inflorescences in relation to rosette size (robust individual with three inflorescences); B – flower and upper part of inflorescence (showing several aborted capsules); C – flower, note the characteristic dark styles in the centre; D – ripe fruit with spreading sepals, showing the long white hairs covering the sepals; E, F – close-up of styles and ovary; G – rosette, note the reflexed, senesced wet season leaves supporting the plant; H – seed; I – top view of rosette; J – habitat. Scale bars = 1 cm (A–D, G); 1 mm (E, F, I); 100 µm (H). Photographs taken *in situ* by N. Juve (A–G, I, J), and from the holotype *H. Demarz* 8887 by T. Krueger (H).

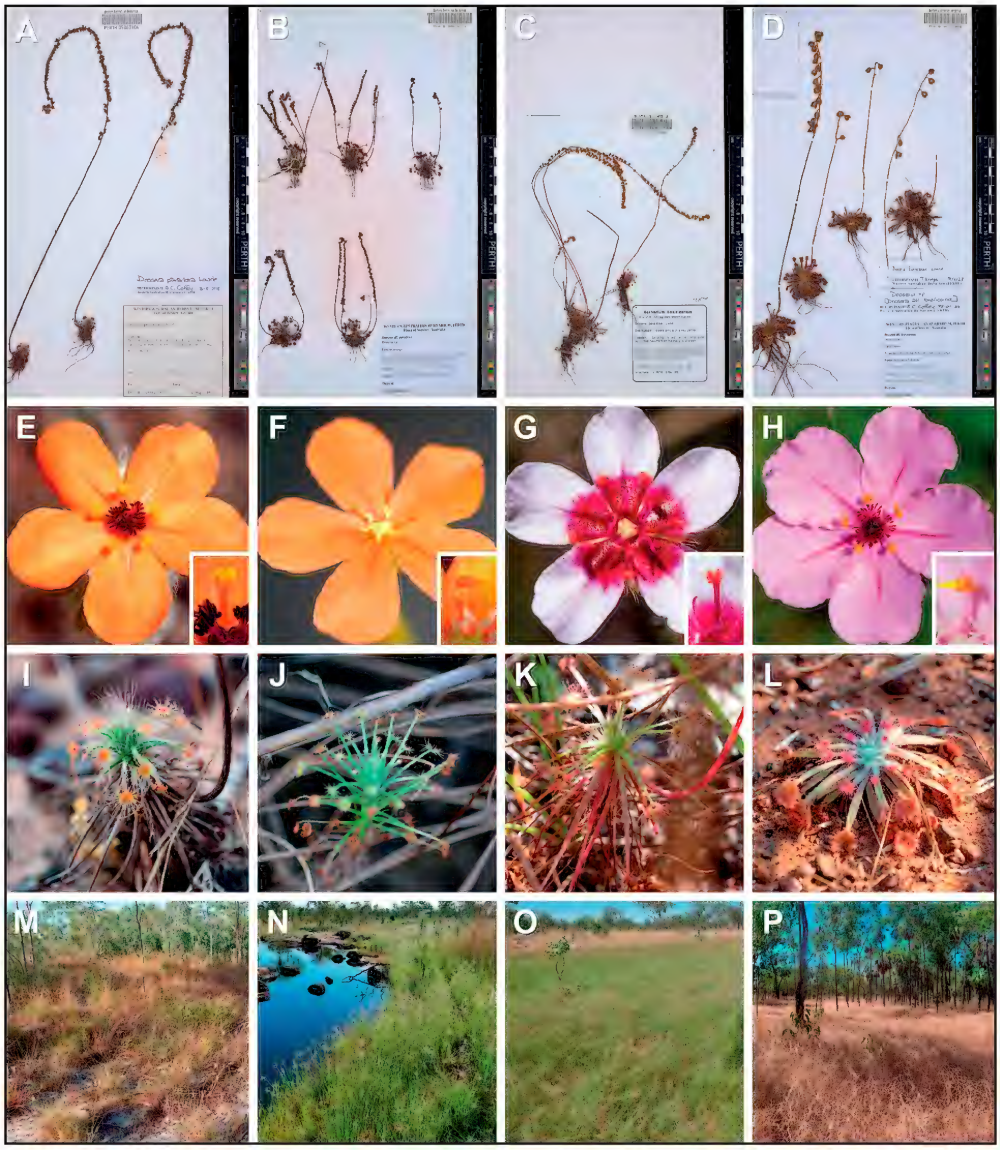

Figure 3. Comparison of *Drosera actinioides* (left column), *D. paradoxa* 'orange flowered form' (centre-left column), bicoloured individuals of *D. paradoxa* 'swamp form' (centre-right column), and *D. brevicornis* (right column). A–D – herbarium specimens, showing differences in inflorescence number and length in relation to rosette size; E–H – flowers, with anthers shown in inset. Note the differences in ovary colour, style colour and shape, and pollen colour, and the presence of a prolonged anther connective, or 'stamen hook', in H (indicated with yellow arrow); I–L – side view of leaf rosettes during the beginning of the dry season, showing the comparatively flat rosette of *D. brevicornis* (L); M–P – habitat. Note the moist herbfield habitats inhabited by *D. paradoxa s. lat.* (N, O) in contrast to the dry laterite or white sand habitats inhabited by *D. actinioides* (M) and *D. brevicornis* (P). Herbarium specimen images by the Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions. Photographs by N. Juve (E, G, I, K, L, M, P), T. Krueger (F, H, N, O), and A. Fleischmann (J).

D. actinioides (Environmental Protection Authority 2021). Changing fire regimes and rainfall patterns may represent additional threats.

Etymology. The specific epithet is derived from the widespread sea anemone genus *Actinia* Linnaeus, 1758 (from Greek '*aktis*, *aktin*' = ray, beam) and the Greek suffix '*-oides*' (denoting likeness to), a reference to the distinctive, highly branched styles (Figure 2E, F), which superficially resemble the red tentacles produced by species of *Actinia*. The semi-globose leaf rosette and highly divided, long, narrow stipules also display an allusion to the medusoid morphology of *Actinia*.

Affinities. *Drosera actinioides* is morphologically most similar to *D. paradoxa s. lat.*, as evidenced by its elongated internodes, semi-globose leaf orientation, prominent stipules, and late-season flowering. While its floral morphology resembles *D. paradoxa* 'orange flowered form' (which likewise has orange petals but is not known to occur within the range of *D. actinioides*) and bicoloured individuals (first depicted in Lowrie *et al.* 2017: 853) of *D. paradoxa* 'swamp form' (which also have red to dark red styles and are known from within the range of *D. actinioides*), it is easily distinguished by its highly branched styles, yellow pollen, and a disproportionally tall inflorescence with a long, thick, self-supporting peduncle (Table 1; Figure 3). *Drosera brevicornis* Lowrie shares several notable features with *D. actinioides* (i.e. a similarly robust inflorescence, highly branched styles, and a preference for arid, often lateritic habitats), but differs by its flat rosette, pink (or rarely white) petals, and distinctive stamen 'hooks' (prolonged anther connectives; Table 1; Figure 3). Examination of herbarium specimens and recent surveys have failed to document *D. brevicornis* within the known range of *D. actinioides*, although it was recorded from *c.* 18 km south of the southernmost *D. actinioides* location. The poorly known, undescribed *D.* species 'Bigge Island' (Lowrie 2014; Nunn & Lowrie 2021) is morphologically similar in size and habit (small rosettes; long, bristly stipules; short, column-like stems; long inflorescences with a many-flowered rachis) but differs from *D. actinioides* in its putatively perennial growth, pink petals, and wider pedicel spacing.

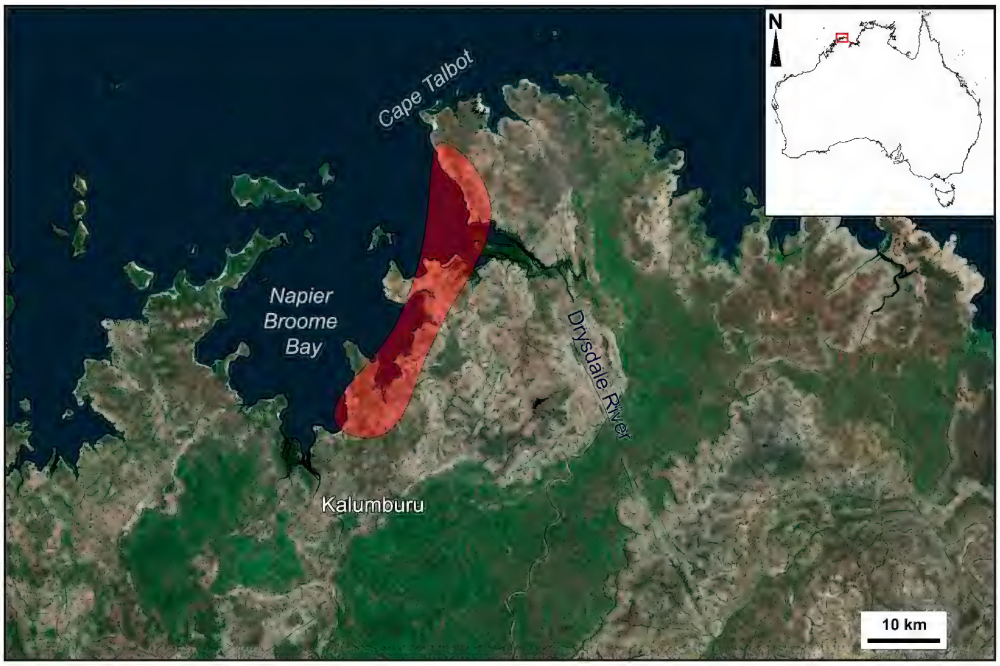

Figure 4. Known distribution of *Drosera actinioides* in the Northern Kimberley bioregion, Western Australia, based on the type collection and five additional localities observed by the authors. Background satellite map ©OpenStreetMap (data is available under the Open Database License; https://www.openstreetmap.org/copyright [accessed 1 February 2025]). Map prepared by A. Fleischmann.

Table 1. Comparison of *Drosera actinioides* with morphologically similar taxa from *D.* sect. *Lasiocephala*.

	Drosera actinioides	*Drosera paradoxa* 'orange flowered form'	*Drosera paradoxa* 'swamp form' – bicoloured individuals	*Drosera brevicornis*
Stem length	1.0–2.5 cm	0.8–4.0 cm	0.9–3.7 cm	< 1.0 cm
Inflorescence number per leaf rosette	1(–3)	1–4	1–4	1(2)
Inflorescence shape	Peduncle thick, strongly ascending, erect, self-supporting, inflorescence disproportionally tall compared to rosette size	Peduncle thin, ascending, erect and self-supporting at early anthesis, later often supported by co-occurring herbs or becoming prostrate	Peduncle thin, ascending, erect and self-supporting at early anthesis, later often supported by co-occurring herbs or becoming prostrate	Peduncle thick, ascending, self-supporting, inflorescence disproportionally large compared to rosette size
Plant height (including inflorescence)	(16–)29–54 cm	7–24 cm	20–45 cm	16–50 cm
Peduncle diameter (near base)	(0.5–)0.7–1.6 mm	0.3–0.7 mm	0.3–0.8 mm	0.8–1.6 mm
Petal colour	Metallic orange	Metallic orange	White (rarely pink) with red or purple base	Pink or white
Stamen 'hooks'	Absent	Absent	Absent	Present
Pollen colour	Yellow	Reddish orange	Reddish orange	Yellow to orange
Ovary colour	Dark red to blackish red	Pale green	Pale green	White, pink, red, or dark purple
Style colour	Dark red to blackish red	White to yellow	Red to dark red	White, pink, red, or purple
Stigma number	(33–)45–66	9–18	11–24	24–45
Anthesis time	March–June	December–April	March–July	December–May
Habitat	Exposed sandy or lateritic flats overlying sandstone associated with Triodia spp.	Grassy seasonal herbfields overlying sandstone pavement	Grassy seasonal herbfields overlying sandstone pavement	Sandy or lateritic flats associated with Sorghum spp.

Drosera actinioides further differs from *D. paradoxa* 'orange flowered form' and bicoloured individuals of *D. paradoxa* 'swamp form' in habitat preference. In contrast to the seasonally wet herbfield habitats overlying sandstone pavement in which the last two taxa occur, *D. actinioides* thrives on shallow, well-drained sandy or lateritic soils apparently lacking sufficient moisture retention to sustain dense vegetation cover (Table 1; Figure 3). Furthermore, flowering of *D. actinioides* is confined to the late wet season and early dry season months (March to early June), in contrast to the primarily annual *D. paradoxa*

'orange flowered form' (which can flower earlier, from December to April) and bicoloured individuals of *D. paradoxa* 'swamp form' (which can flower later, from March to July; Table 1).

Notes. As a putative member of the *D. paradoxa* complex, sharing the erect stems present in all taxa from that affinity, the shoot apex of *D. actinioides* is elevated above the hot lateritic or white sand soil. In contrast, rosetted perennial members of *D.* sect. *Lasiocephala* either reduce growth during the dry season to produce a smaller and often densely woolly, insulated rosette (e.g. *D. broomensis* Lowrie, *D. lanata* K.Kondo, and *D. petiolaris*), or are geophytes, retreating to a subterranean rhizomatous bulb (e.g. *D. caduca* Lowrie, *D. falconeri* K.Kondo & Tsang, and *D. kenneallyi* Lowrie). *Drosera actinioides* has no such protection, indicating the species is most likely an annual therophyte, perishing during May and June. No individuals with condensed stem segments consisting of internodes noticeably reduced in length for the dry season (indicating multi-year stem growth) were observed *in situ* or on the type specimen. Even diminutive individuals with a rosette as little as 0.9 cm in diameter were observed to produce inflorescences, indicating that flowering occurs towards the end of the growth cycle regardless of plant size, a feature observed in other obligate annuals (e.g. *D. banksii*). That said, there is the potential for individuals to persist into the following season in exceptional cases of moisture availability.

Despite its annual habit and short growing season, *D. actinioides* produces the greatest scape length and flower number in relation to rosette diameter known in *D.* sect. *Lasiocephala* (and possibly among all *Drosera* species). It appears to be the only obligate outcrossing (self-incompatible) species among the three described annuals in *D.* sect. *Lasiocephala* (*D. actinioides*, *D. banksii*, and *D. subtilis* N.G.Marchant), a breeding mode inferred from the numerous empty capsules on the infructescences, these being smaller and with fully clasping sepals (Figures 1A; 2B,D). It is possible that the unusually tall inflorescence of *D. actinioides* increases pollination success (see Anderson 2010; Cross *et al.* 2018), which is important for a therophyte highly dependent on seed production. Additionally, no clonal propagation via stem division (as is common in many perennial species of *D.* sect. *Lasiocephala*) was observed in *D. actinioides*. Notably, the exceptionally robust inflorescence of *D. actinioides* is reliably held upright, despite arising from the stem at a height of up to 2.5 cm above the soil surface. To avoid bending along the stem (which would result in an undesirable, prostrate inflorescence orientation), the species likely supports its inflorescence through the combination of a thickened, strongly ascending peduncle, and a conical arrangement of wet season leaves reflexed by *c.* 45° in relation to and firmly contacting the ground (Figure 2G).

The orange and black flowers of *D. actinioides* superficially parallel those of certain pygmy sundews (*D.* sect. *Bryastrum*) native to south-western Australia, which are associated with beetle pollination (Robinson *et al.* 2018). Lacking the petal bicolouration displayed by these members of *D.* sect. *Bryastrum*, the dark styles of *D. actinioides* are responsible for the contrasting colour pattern of the floral display. Analogous to the strong ecological association between red and white-flowered and orange and black-flowered pygmy sundew species, which often co-occur in the same habitat (Lowrie 2014; Lowrie *et al.* 2017), bicoloured individuals of *D. paradoxa* 'swamp form' are particularly abundant within the geographic range of *D. actinioides*.

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Updates to Western Australia's vascular plant census for 2024

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SHORT COMMUNICATION

The census database at the Western Australian Herbarium (PERTH), which provides the nomenclature for the website *Florabase* (Western Australian Herbarium 1998–), lists current names and recent synonymy for Western Australia's native and naturalised vascular plants, as well as algae, bryophytes, lichens, slime moulds and some fungi. The names represented in the census are either sourced from published research or denote as yet unpublished names based on herbarium voucher specimens. We herein summarise the changes made to vascular plant names in this database during 2024.

Ninety-one taxa were newly recorded for the State, of which 13 are naturalised and 58 have been added to the *Threatened and Priority Flora list for Western Australia* (State of Western Australia 2024; Western Australian Herbarium 1998–) (Table 1). A total of 100 name changes were made, including the formal publication of 22 phrase-named taxa (Table 2). Plant groups for which several name changes were made include *Pultenaea* Sm. and *Thryptomene* Endl. Several naturalised genera were added to the WA Plant Census as part of a grant received from the Atlas of Living Australia to mobilise biodiversity data, including *Crassocephalum* Moench, *Hydrocharis* L., *Juniperus* L., *Ochna* L, *Praxelis* Cass. and *Scolopia* Schreb. Table 2 also includes cases where there has been a change of taxonomic concept, misapplication, exclusion, or rank change.

Table 1. New records added to Western Australia's vascular plant census during 2024. *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Conservation Codes for Western Australian Flora (State of Western Australia 2024; Western Australian Herbarium 1998–).

New Name	Status	Comments
Acacia sp. Gifford Station (J.P. Bull ONS-5724)	P1	J.P. Bull *in litt.* (28/11/2023).
Acacia sp. Jarrahdale (D. Rubick 155)	P1	R. Davis & M. Hislop *in litt.* (02/12/2021).
Acer pseudoplatanus L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (05/12/2024).
Aloe ciliaris Haw.	*	New naturalised record for WA. G.J. Keighery *in litt.* (18/09/2024).
Aloe ciliaris Haw. var. *ciliaris*	*	New naturalised record for WA. G.J. Keighery *in litt.* (18/09/2024).
Amphipogon sp. Southern Cross (T.D. Macfarlane et al. TDM 7193)	P1	M. Karunakaram *in litt.* (15/02/2024).
Aponogeton queenslandicus H.Bruggen	P1	New record for WA. T.D. Macfarlane & M.N. Lyons *in litt.* (29/01/2024).
Brachyachne anisocarpa Albr.	P1	See Albrecht & McLay (2022).

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New Name	Status	Comments
Cathetus sp. Yampi gilgai (J.P. Bull & D. Brearley ONS-4673)	P1	J.P. Bull *in litt.* (11/03/2024).
Chamelaucium sp. Coolgardie (P. Pavlovic 289)	P1	M. Hislop & B.L. Rye *in litt.* (03/05/2024).
Chamelaucium sp. King Ingram (G. Grigg WB40916)	P1	M. Hislop & B.L. Rye *in litt.* (03/05/2024).
Chamelaucium sp. Mount Holland (G. Cockerton & G. Grigg WB40918)	P1	M. Hislop & B.L. Rye *in litt.* (03/05/2024).
Crassocephalum crepidioides (Benth.) S.Moore	*	New naturalised record for WA. G.J. Keighery *in litt.* (13/08/2024).
Eremophila sp. Kulin (R.J. Chinnock 10713)	P1	R.J. Chinnock *in litt.* (16/01/2024).
Eucalyptus caesia subsp. *boodjin* D.Nicolle & M.E.French	P2	See Nicolle & French (2023).
Eucalyptus marginata subsp. *spurgeana* D.Nicolle & M.E.French		See Nicolle & French (2023).
Eucalyptus polita subsp. *ocreata* D.Nicolle & M.E.French	P3	See Nicolle & French (2023).
Eucalyptus polita Brooker & Hopper subsp. *polita*	P3	Implicit autonym. See Nicolle & French (2023).
Eucalyptus sweedmaniana subsp. *noongaring* Hopper	P4	See Hopper (2024b).
Eucalyptus sweedmaniana Hopper & McQuoid subsp. *sweedmaniana*	P2	Implicit autonym. See Hopper (2024b).
Eucalyptus urna D.Nicolle subsp. *urna*	P3	Implicit autonym. See Nicolle & French (2023).
Ficus sp. Yampi (J.P. Bull & D.R. Brearley ONS-4750)	P1	J.P. Bull *in litt.* (17/12/2023).
Fimbristylis complanata (Retz.) Link		New record for WA. M. Hislop *in sched.* (05/12/2024).
Goodenia sp. Great Sandy Desert (D.E. Albrecht 10517)		New record for WA. L.W. Sage *in litt.* (06/11/2024).
Goodenia sp. Karlamilyi (L.W. Sage LWS 2997)	P2	L.W. Sage *in litt.* (12/11/2024).
Goodenia sp. Wanna (S. Kern & A.I. Craigie 3397-15091-4)	P1	L.W. Sage *in litt.* (22/10/2024).
Goodenia sp. Wiluna (R.D. Royce 10409)	P3	L.W. Sage *in litt.* (07/11/2024).
Grevillea kulikup Olde	P1	See Olde *et al.* (2024).
Hemigenia glaucissima A.J.Perkins	P1	See Perkins (2024).
Hibbertia arenicola K.R.Thiele	P2	See Thiele & Hammer (2024b).
Hibbertia callida K.R.Thiele		See Thiele (2024).
Hibbertia elachophylla K.R.Thiele & T.Hammer	P1	See Thiele & Hammer (2024b).
Hibbertia erioclada K.R.Thiele	P1	See Thiele & Hammer (2024b).
Hibbertia humilis K.R.Thiele	P2	See Thiele & Hammer (2024a).
Hibbertia juniperina (Turcz.) K.R.Thiele		See Thiele (2024).
Hibbertia lanulipes K.R.Thiele	P1	See Thiele & Hammer (2024b).
Hibbertia leptophylla K.R.Thiele		See Thiele & Hammer (2024c).
Hibbertia micrantha K.R.Thiele & T.Hammer	P1	See Thiele & Hammer (2024a).

New Name	Status	Comments
Hibbertia parvula K.R.Thiele		See Thiele & Hammer (2024a).
Hibbertia simkiniae K.R.Thiele		See Thiele (2024).
Hibbertia xenandra K.R.Thiele		See Thiele & Hammer (2024a).
Hibiscus calcareus McLay & Albr.	P2	See McLay *et al.* (2023).
Hibiscus sp. Belele (D.W. Goodall 3417)	P3	See McLay *et al.* (2023).
Juniperus virginiana L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (18/09/2024).
Kunzea sp. Wongan Hills (A.M. Coates 3045)	P3	M. Hislop *in litt.* (08/08/2024).
Lachenalia pallida Aiton	*	New naturalised record for WA. G.J. Keighery *in litt.* (27/11/2024).
Lagerstroemia indica L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (13/08/2024).
Leucopogon longipes Hislop	P1	See Hislop & Barrett (2024).
Melaleuca sp. Prince Regent (W. O'Sullivan & D. Dureau WODD 71)	P1	M.D. Barrett *in litt.* (02/07/2024).
Minuria sp. Murchison (T. Lowrey 1713)	P1	B. Anderson & S. Dillon *in litt.* (30/09/2024).
Minuria sp. Onslow (A.J. Perkins & M. Henson AJP-WA167)	P3	B. Anderson & S. Dillon *in litt.* (30/09/2024).
Mitrasacme micrantha Domin	P2	New record for WA. M.D. Barrett *in litt.* (02/07/2024).
Murdannia cryptantha Faden	P1	New record for WA. M.D. Barrett *in litt.* (09/02/2024).
Myoporum sp. Ningaloo (S. Colwill 14)	P1	M. Hislop *in litt.* (01/08/2024).
Myriocephalus sp. Lake Cronin (K. Newbey 5187)	P2	G.J. Keighery *in litt.* (09/02/2024).
Ochna serrulata (Hochst.) Walp.	*	New naturalised record for WA. G.J. Keighery *in litt.* (05/12/2024).
Passiflora foetida var. *ellisonii* Vanderpl.	*	See Vanderplank (2013).
Persoonia sp. Great Victoria Desert (K. Tribbeck KRT681)	P1	M. Hislop *in litt.* (05/11/2024).
Platanus orientalis L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (27/11/2024).
Plecostachys serpyllifolia (P.J.Bergius) Hilliard & B.L.Burtt	*	New naturalised record for WA. See Hopper (2024a).
Praxelis clematidea R.M.King & H.Rob.	*	New naturalised record for WA. G.J. Keighery *in litt.* (07/11/2024).
Pseudognaphalium lanatum (G.Forst.) Smissen, Breitw. & de Lange		G.J. Keighery *in sched.* (09/10/2024); see also Schmidt-Lebuhn (2024).
Scolopia braunii (Klotzsch) Sleumer	P2	New record for WA. M.D. Barrett *in litt.* (02/07/2024).
Senegalia albizioides (Pedley) Pedley		New record for WA. B.R. Maslin *in litt.* (02/02/2024).
Stylidium anomalum Wege	P3	See Wege *et al.* (2024).
Stylidium aquaticum A.R.Bean	P3	New record for WA. See Wege *et al.* (2024).
Stylidium brennanianum Wege, M.D.Barrett & A.R.Bean	P3	See Wege *et al.* (2024).
Stylidium capillare R.Br.	P3	New record for WA. See Wege *et al.* (2024).

New Name	Status	Comments
Stylidium incognitum Wege	P2	See Wege *et al.* (2024).
Stylidium modicum M.D.Barrett, R.L.Barrett & Wege		See Wege *et al.* (2024).
Stylidium pezidium Wege, Brennan & S.J.Dillon		See Wege *et al.* (2024).
Stylidium synaptum Wege, Brennan & A.R.Bean	P3	See Wege *et al.* (2024).
Stylidium tenerrimum F.Muell.	P1	New record for WA. See Wege *et al.* (2024).
Stylidium tremendum Wege, M.D.Barrett & R.L.Barrett		See Wege *et al.* (2024).
Stylidium youwanjela M.D.Barrett, R.L.Barrett & Wege	P2	See Wege *et al.* (2024).
Styphelia altivallis Hislop	P1	See Hislop (2024b).
Styphelia innoxia Hislop	P2	See Hislop (2024b).
Styphelia longiloba Hislop		See Hislop (2024b).
Tecticornia crotalus K.A.Sheph. & Zerdoner	P2	See Shepherd & Žerdoner Čalasan (2024).
Tecticornia dactylifera K.A.Sheph. & Zerdoner	P1	See Shepherd & Žerdoner Čalasan (2024).
Thryptomene caduca Rye & Trudgen subsp. *caduca*	P1	See Rye (2024).
Thryptomene caduca subsp. *incurva* Rye	P3	See Rye (2024).
Thryptomene dampieri subsp. *capensis* Rye	P3	See Rye (2024).
Thryptomene dampieri Rye subsp. *dampieri*		See Rye (2024).
Thryptomene maritima Rye		See Rye (2024).
Thyridia sp. Northern saline floodplains (A. Markey & S. Dillon FM 10730)		A. Markey *in litt.* (27/08/2024).
Thysanotus ellipsoideus T.Macfarlane & C.J.French		See Macfarlane & French (2024).
Thysanotus prospectus C.J.French & T.Macfarlane		See Macfarlane & French (2024).
Trianoptiles solitaria (C.B.Clarke) Levyns	*	New naturalised record for WA. See Hopper (2024a).
Triodia sp. Pannawonica shale (P.J. Davidson PJD 2026)	P1	M.D. Barrett *in litt.* (20/12/2023).
Vallisneria kristinae R.W.Jobson & Dunning	P3	See Jobson & Dunning (2024).

Table 2. Changes to existing entries in Western Australia's vascular plant census during 2024. Excluded taxon = a name used in the botanical literature that refers to a taxon never occurring in WA; misapplied name = a name used in the botanical literature but now considered to refer to one or more different WA taxa; nomenclatural synonym = a superseded name based on the same type specimen as the accepted name; taxonomic synonym = a superseded name based on a different type specimen to the accepted name; *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Department of Biodiversity, Conservation and Attractions Conservation Codes for Western Australian flora (State of Western Australia 2024; Western Australian Herbarium 1998–).

Old Name	New Name	Status	Comments
Aloe ciliaris Haw.	*Aloiampelos ciliaris* (Haw.) Klopper & Gideon F.Sm.	*	Nomenclatural synonym. See Grace *et al.* (2013).
Aloe ciliaris Haw. var. *ciliaris*	*Aloiampelos ciliaris* (Haw.) Klopper & Gideon F.Sm. var. *ciliaris*	*	Nomenclatural synonym. See Grace *et al.* (2013).
Alyogyne sp. Great Victoria Desert (D.J. Edinger 6212)	*Alyogyne leptochlamys* (Benth.) P.J.Lang		Name synonymised. See Lang *et al.* (2023).
Alyogyne sp. Hyden (G.S. Durell GD 127)	*Alyogyne leptochlamys* (Benth.) P.J.Lang		Name synonymised. See Lang *et al.* (2023).
Brachyachne anisocarpa Albr.	*Cynodon anisocarpus* (Albr.) T.Macfarlane	P1	Nomenclatural synonym. See Macfarlane (2024).
Calandrinia sp. Edel Land (F. Obbens FO 01/17)	*Calandrinia sphaerophylla* J.M.Black	P2	Name synonymised. See Obbens (2024).
Capparis lucida (DC.) Benth.	n/a		Excluded taxon. This taxon does not occur in WA. W. Cooper *in litt.* (14/09/2024).
Eriachne sp. Mitchell Plateau (M.D. Barrett & R.L. Barrett MDB 1517)	*Eriachne pauciflora* W.Fitzg.		Name synonymised. M.D. Barrett *in litt.* (02/07/2024).
Eucalyptus leptopoda subsp. *arctata* L.A.S.Johnson & K.D.Hill	*Eucalyptus arctata* (L.A.S.Johnson & K.D.Hill) D.Nicolle & M.E.French		Nomenclatural synonym. See Nicolle & French (2023).
Eucalyptus merleae McQuoid & M.E.French	*Eucalyptus astringens* subsp. *merleae* (McQuoid & M.E.French) D.Nicolle & M.E.French	P2	Nomenclatural synonym. See Nicolle & French (2023).
Eucalyptus sp. Dunbar Road (D. Nicolle & M. French DN 5466)	*Eucalyptus urna* subsp. *xesta* D.Nicolle & M.E.French	P3	Taxon formally published. See Nicolle & French (2023).
Eucalyptus sp. Southern Wheatbelt (D. Nicolle & M. French DN 5507)	*Eucalyptus scyphata* D.Nicolle & M.E.French		Taxon formally published. See Nicolle & French (2023).
Euchiton collinus Cass.	*Euchiton japonicus* (Thunb.) Holub		Taxonomic synonym. See Schmidt-Lebuhn (2024).
Goodenia coerulea R.Br.	*Goodenia caerulea* R.Br.		Orthographic variant. A. Monro *in litt.* (06/03/2024).
Goodenia sp. Sandy Creek (R.D. Royce 1653)	*Goodenia vanleeuweniana* L.W.Sage & K.A.Sheph.		Taxon formally published. See Sage & Shepherd (2024).
Goodenia sp. South Coast (A.R. Annels ARA 1846)	*Goodenia austrina* L.W.Sage & K.A.Sheph.	P3	Taxon formally published. See Sage & Shepherd (2024).
Heliophila sp. Gunyidi (R.G. Rees 42)	*Heliophila seselifolia* DC.	*	Name synonymised. G.J. Keighery *in litt.* (18/09/2024).
Hibbertia glomerata subsp. *wandoo* J.R.Wheeler	*Hibbertia wandoo* (J.R.Wheeler) T.Hammer & K.R.Thiele	P3	Nomenclatural synonym. See Hammer & Thiele (2024).
Hibbertia glomerosa var. *bistrata* J.R.Wheeler	*Hibbertia bistrata* (J.R.Wheeler) K.R.Thiele & T.Hammer	P3	Nomenclatural synonym. See Thiele & Hammer (2024).
Hibbertia glomerosa (Benth.) F.Muell. var. *glomerosa*	*Hibbertia glomerosa* (Benth.) F.Muell.		Nomenclatural synonym. No varieties recognised. See Thiele & Hammer (2024).
Hibbertia hibbertioides (Steud.) J.R.Wheeler var. *hibbertioides*	*Hibbertia hibbertioides* (Steud.) J.R.Wheeler		Nomenclatural synonym. See Hammer & Thiele (2024).
Hibbertia hibbertioides var. *meridionalis* J.R.Wheeler	*Hibbertia meridionalis* (J.R.Wheeler) T.Hammer & K.R.Thiele		Nomenclatural synonym. See Hammer & Thiele (2024).
Hibbertia hibbertioides var. *pedunculata* J.R.Wheeler	*Hibbertia hibbertioides* (Steud.) J.R.Wheeler		Taxonomic synonym. See Hammer & Thiele (2024).
Hibbertia sp. Dragon Rocks (A.M. Coates 2875)	*Hibbertia dracolithica* K.R.Thiele	P2	Taxon formally published. See Thiele & Hammer (2024).

Old Name	New Name	Status	Comments
Isopogon buxifolius R.Br. var. *buxifolius*	*Isopogon buxifolius* R.Br.	T	Nomenclatural synonym. No subspecies recognised. See Anderson *et al.* (2024).
Isopogon buxifolius var. *obovatus* (R.Br.) Benth.	*Isopogon spathulatus* subsp. *obovatus* (R.Br.) Rye & Hislop	P3	Nomenclatural synonym. See Anderson *et al.* (2024).
Isopogon sp. Canning Reservoir (M.D. Tindale 121 & B.R. Maslin)	*Isopogon spathulatus* R.Br. subsp. *spathulatus*		Name synonymised. See Anderson *et al.* (2024).
Isopogon sp. Darling Range (F. Hort 1662)	*Isopogon pallidus* Hislop & Rye		Taxon formally published. See Anderson *et al.* (2024).
Isopogon sp. Fitzgerald River (D.B. Foreman 813)	*Isopogon spathulatus* subsp. *elongatus* Rye & Hislop		Taxon formally published. See Anderson *et al.* (2024).
Isopogon sp. Ravensthorpe (D.B. Foreman 1207)	*Isopogon elatus* Rye & Hislop	P4	Taxon formally published. See Anderson *et al.* (2024).
Leucopogon sp. Bremer Bay (K.R. Newbey 4667)	*Styphelia microcardia* Hislop	P3	Taxon formally published. See Hislop (2024a).
Leucopogon sp. Coomallo (R.J. Cranfield 1457)	*Styphelia speciosa* Hislop		Taxon formally published. See Hislop (2024a).
Leucopogon sp. Dumbleyung (M. Hislop & F. Hort MH 3239)	*Styphelia tarinensis* Hislop	P2	Taxon formally published. See Hislop (2024a).
Leucopogon sp. Lort River (M. Golding 3)	*Styphelia halophila* Hislop		Taxon formally published. See Hislop (2024a).
Leucopogon sp. Mid West (J.S. Beard 7388)	*Styphelia* sp. Mid West (J.S. Beard 7388)		Name synonymised. M. Hislop *in litt.* (03/04/2024).
Leucopogon sp. Mount Heywood (M.A. Burgman 1211)	*Styphelia lacsalaria* Hislop		Taxon formally published. See Hislop (2024a).
Leucopogon sp. Yanchep (M. Hislop 1986)	*Styphelia porcata* Hislop	P3	Name synonymised. See Hislop (2024b).
Limnobium laevigatum (Willd.) Heine	*Hydrocharis laevigata* (Willd.) Byng & Christenh.	*	Nomenclatural synonym. See Garcia-Murillo (2023).
Microcorys macredieanus F.Muell.	*Microcorys macredieana* F.Muell.		Orthographic variant. A.S. George *in litt.* (20/02/2024).
Microcorys sp. Boxwood (K.R. Newbey 4200)	*Microcorys glabra* var. *pubescens* Benth.	P3	Name synonymised. G. Guerin *in litt.* (15/05/2023).
Paraneurachne muelleri (Hack.) S.T.Blake	*Neurachne muelleri* Hack.		Nomenclatural synonym. See Thompson & Fabillo (2021).
Proiphys alba (R.Br.) Mabb.	*Proiphys kimberleyensis* M.D.Barrett & R.L.Barrett	P1	Misapplied name. See Barrett & Barrett (2015).
Pterostylis sp. Murchison (C.J. French CJF 12549)	*Pterostylis argillacea* G.Brockman & C.J.French	P2	Taxon formally published. See Brockman & French (2024).
Pterostylis sp. Paynes Find (G. Brockman GBB 526)	*Pterostylis arida* G.Brockman & C.J.French	P3	Name synonymised. See Brockman & French (2024).
Pterostylis sp. scooped sepals (G. Brockman GBB386)	*Pterostylis arida* G.Brockman & C.J.French	P3	Name synonymised. See Brockman & French (2024).
Ptilotus seminudus (J.M.Black) J.M.Black	*Ptilotus ostentans* T.Hammer & R.W.Davis	P3	Misapplied name. See Hammer & Davis (2024).
Pultenaea arida E.Pritz.	*Euchilus aridus* (E.Pritz.) R.L.Barrett & Orthia		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea aspalathoides Meisn.	*Loricobbia aspalathoides* (Meisn.) R.L.Barrett & T.Macfarlane		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea brachyphylla Turcz.	*Jennata brachyphylla* (Turcz.) R.L.Barrett & Clugston	P2	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea brachytropis Benth.	*Grievea brachytropis* (Lindl.) R.L.Barrett & Orthia		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea calycina (Turcz.) Benth.	*Euchilus calycinus* Turcz.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea calycina (Turcz.) Benth. subsp. *calycina*	*Euchilus calycinus* Turcz. subsp. *calycinus*	P3	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea calycina subsp. *proxena* Orthia & Chappill	*Euchilus calycinus* subsp. *proxenus* (Orthia & Chappill) Orthia & R.L.Barrett	P4	Nomenclatural synonym. See Barrett *et al.* (2024).

Old Name	New Name	Status	Comments
Pultenaea craigiana C.F.Wilkins, Orthia & Crisp	*Grievea craigiana* (C.F.Wilkins, Orthia & Crisp) Orthia & R.L.Barrett	P3	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea cymbifolia J.M.Black	*Euchilus elachistus* (F.Muell.) R.L.Barrett & Orthia		Taxonomic synonym. See Barrett *et al.* (2024).
Pultenaea daena Orthia & Chappill	*Euchilus daena* (Orthia & Chappill) Orthia & R.L.Barrett	P3	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea elachista (F.Muell.) Crisp	*Euchilus elachistus* (F.Muell.) R.L.Barrett & Orthia		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea empetrifolia Meisn.	*Jennata empetrifolia* (Meisn.) R.L.Barrett & Clugston		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea ericifolia Benth.	*Jennata ericifolia* (Benth.) R.L.Barrett & Clugston		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea heterochila F.Muell.	*Euchilus obcordatus* R.Br.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea indira Orthia & Crisp	*Jennata indira* (Orthia & Crisp) Orthia & R.L.Barrett		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea indira Orthia & Crisp subsp. *indira*	*Jennata indira* (Orthia & Crisp) Orthia & R.L.Barrett subsp. *indira*		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea indira subsp. *monstrosita* Orthia	*Jennata indira* subsp. *monstrosita* (Orthia) Orthia & R.L.Barrett	P3	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea indira subsp. *pudoides* Orthia	*Jennata indira* subsp. *pudoides* (Orthia) Orthia & R.L.Barrett	P2	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea obcordata (R.Br.) Benth.	*Euchilus obcordatus* R.Br.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea ochreata Meisn.	*Loricobbia ochreata* (Meisn.) R.L.Barrett & T.Macfarlane		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea pauciflora M.B.Scott	*Loricobbia pauciflora* (M.B.Scott) R.L.Barrett & T.Macfarlane	T	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea pinifolia Meisn.	*Loricobbia pinifolia* (Meisn.) R.L.Barrett & T.Macfarlane	P3	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea pteronioides Turcz.	*Jennata strobilifera* (Meisn.) R.L.Barrett & Clugston		Taxonomic synonym. See Barrett *et al.* (2024).
Pultenaea purpurea (Turcz.) Crisp & Orthia	*Euchilus purpureus* Turcz.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea quaerita Orthia	*Euchilus obcordatus* R.Br.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea radiata H.B.Will.	*Jennata radiata* (H.B.Will.) R.L.Barrett & Clugston		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea reticulata (Sm.) Benth.	*Loricobbia reticulata* (Sm.) R.L.Barrett & T.Macfarlane		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea rotundifolia (Turcz.) Benth.	*Euchilus rotundifolius* Turcz.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea skinneri F.Muell.	*Loricobbia skinneri* (F.Muell.) R.L.Barrett & T.Macfarlane	P4	Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea sp. Clyde Hill (K.R. Newbey 8236)	*Euchilus elachistus* (F.Muell.) R.L.Barrett & Orthia		Name synonymised. See Barrett *et al.* (2024).
Pultenaea sp. Kundip (G.F. Craig 6008)	*Grievea craigiana* (C.F.Wilkins, Orthia & Crisp) Orthia & R.L.Barrett	P3	Name synonymised. See Barrett *et al.* (2024).
Pultenaea sp. Mt Lesueur (J.S. Beard 7827)	*Jennata* sp. Mt Lesueur (J.S. Beard 7827)	P2	Name synonymised. See Barrett *et al.* (2024).
Pultenaea sp. southern (L.A. Orthia 39)	*Jennata* sp. southern (L.A. Orthia 39)		Name synonymised. See Barrett *et al.* (2024).
Pultenaea spinulosa (Turcz.) Benth.	*Euchilus spinulosus* Turcz.		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea strobilifera Meisn.	*Jennata strobilifera* (Meisn.) R.L.Barrett & Clugston		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea verruculosa Turcz.	*Jennata verruculosa* (Turcz.) R.L.Barrett & Clugston		Nomenclatural synonym. See Barrett *et al.* (2024).
Pultenaea verticillata Turcz.	*Jennata empetrifolia* (Meisn.) R.L.Barrett & Clugston		Taxonomic synonym. See Barrett *et al.* (2024).

Old Name	New Name	Status	Comments
Scaevola brookeana F.Muell.	*Scaevola brooksiana* F.Muell.	P2	Orthographic variant. See CHAH (2014).
Stackhousia monogyna Labill.	n/a		Excluded taxon. WA specimens are referable to *S. huegelii*, *S. pubescens* and *S.* sp. Hairy fruited (E.N.S. Jackson 1387). W.R. Barker *in litt.* (Feb. 2024).
Thryptomene sp. Carrarang (M.E. Trudgen 7420)	*Thryptomene maritima* subsp. *freycinetensis* Rye	P1	Taxon formally published. See Rye (2024).
Thryptomene sp. Eagle Gorge (A.G. Gunness 2360)	*Thryptomene conica* Rye	P2	Taxon formally published. See Rye (2024).
Thryptomene sp. Hyden (B.J. Lepschi & L.A. Craven 4477)	*Thryptomene jilbadji* Rye	P1	Taxon formally published. See Rye (2024).
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	*Thryptomene butleri* Rye	P3	Taxon formally published. See Rye (2024).
Thryptomene sp. Leinster (B.J. Lepschi & L.A. Craven 4362)	*Thryptomene decussata* (W.Fitzg.) J.W.Green		Name synonymised. See Rye (2024).
Thryptomene sp. Mt Clara (R.J. Cranfield 11702)	*Thryptomene interzonensis* Rye	P1	Taxon formally published. See Rye (2024).
Thryptomene sp. Red Bluff (A.G. Gunness 2358)	*Thryptomene maritima* Rye subsp. *maritima*		Taxon formally published. See Rye (2024).
Thryptomene sp. Wandana (M.E. Trudgen MET 22016)	*Thryptomene pieroniae* Rye	P3	Taxon formally published. See Rye (2024).
Thysanotus sp. Ennuin (N. Gibson & M. Lyons 2665)	*Thysanotus argillaceus* T.Macfarlane & C.J.French	P1	Taxon formally published. See Macfarlane & French (2024).
Tricoryne sp. Wongan Hills (B.H. Smith 794)	*Tricoryne soullierae* T.Macfarlane & Keighery	P1	Name synonymised. T.D. Macfarlane *in litt.* (17/12/2024).
Urochloa decumbens (Stapf) R.D.Webster	*Urochloa eminii* (Mez) Davidse	*	Taxonomic synonym. See Oulo *et al.* (2023).
Urochloa humidicola (Rendle) Morrone & Zuloaga	*Urochloa dictyoneura* (Fig. & De Not.) Veldkamp	*	Taxonomic synonym. See Oulo *et al.* (2023).
Urochloa mosambicensis (Hack.) Dandy	*Urochloa trichopus* (Hochst.) Stapf	*	Taxonomic synonym. See Oulo *et al.* (2023).
Urochloa subquadripara (Trin.) R.D.Webster	*Urochloa distachyos* (L.) T.Q.Nguyen		Taxonomic synonym. See Oulo *et al.* (2023).
Vallisneria triptera S.W.L.Jacobs & K.A.Frank	n/a		Excluded taxon. This taxon does not occur in WA. See Jobson & Dunning (2024).

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Pseudobryopsis australis (Ulvophyceae, Pseudobryopsidaceae), a new species of marine green algae from south-west Western Australia

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SHORT COMMUNICATION

Pseudobryopsis australis Huisman & Verbr., *sp. nov.*

Type: Cape Peron, 22 February 2018, *J.M. Huisman* 22.2.18.1.1 (*holo*: PERTH 09183507).

[*Pseudobryopsis hainanensis auct. non* C.K.Tseng: J.M. Huisman, *Mar. Pl. Australia* 367, 2 unnumbered figures (2023).]

Thallus upright, bright green, siphonous, to 7–10 cm in height, with several terete, primary axes growing from a rhizoidal plexus. Primary axes 0.8–1 mm diam, tapering slightly to apices, simple or generally dichotomously or subdichotomously branched every 7–20 mm, with constrictions at base of branches, densely radially covered by lateral ramuli to near the base. Branches (primary axes plus ramuli) 5–8 mm diam. Ramuli straight or inwardly curved, simple, terete, 4–5 mm long, constricted at base, inflated and rounded, to 70–85 µm diam., tapering to 55–60 µm diam., then 50 µm diam. mid ramulus and 35 µm diam. at the rounded apices. Plastids subspherical to ellipsoidal. 2–4 µm diam., without an obvious pyrenoid. Mature gametangia borne 1 or 2 per ramulus, close to base, initially with an open connection to the ramulus but this eventually occluded. Spent gametangia often present as empty walls, in addition to mature gametangia. Gametangia 100–120 µm long, 65–85 µm diam., ellipsoidal or obovoid, with an apical papilla. (Figure 1)

Diagnostic features. *Pseudobryopsis australis* is the only species of the genus to occur in the southwest of Western Australia. It can be distinguished by its size (7–10 cm in height), branched upright axes to 1 mm diam., dense covering of relatively long ramuli (2–4 mm long), and gametangia lacking a distinct pedicel.

Specimens examined. WESTERN AUSTRALIA: Rottnest Is., 6 Apr. 1989, *J.M. Huisman* JH 1499 (PERTH 06546587); Narrow Neck, Rottnest Is., 10 m depth, 16 Sep. 1994, *J.M. Huisman* JH 327 (PERTH 06546935); Carnac Is., 7 Dec. 1995, *J.M. Huisman* JH 628 (PERTH 06546927); off The Basin, Rottnest Is., 31 Oct. 2009, *J.M. Huisman s.n.* (PERTH 08813973); Roe Reef, Rottnest Is., 17 Dec. 2009, *J.M. Huisman s.n.* (PERTH 08187851); Straggler Reefs, 20 Dec. 2011, *J.M. Huisman* 20.12.11.1.1 (PERTH 08924007); Cape Peron, epilithic at 2 m depth, 28 Feb. 2019, *J.M. Huisman s.n.* (PERTH 09184651); Cape Peron, 25 Feb. 2021, *J.M. Huisman* 25.2.21.2 (PERTH 09316752); Cape Peron, 24 Feb. 2022, *J.M. Huisman* 24.2.22.6 (PERTH 09564128); The Nook, [Houtman] Abrolhos Islands, 15-20 m depth, 3 Dec. 1988, *J.M. Huisman & P. Dingle* HA 276 (PERTH 06524443); Penguin Is., Safety Bay, growing on sandstone, 13 Dec. 1984, *G.T. Kraft* K-GEN-7653e & *J.M. Huisman* (MEL 2526431A; MELUA130008a);

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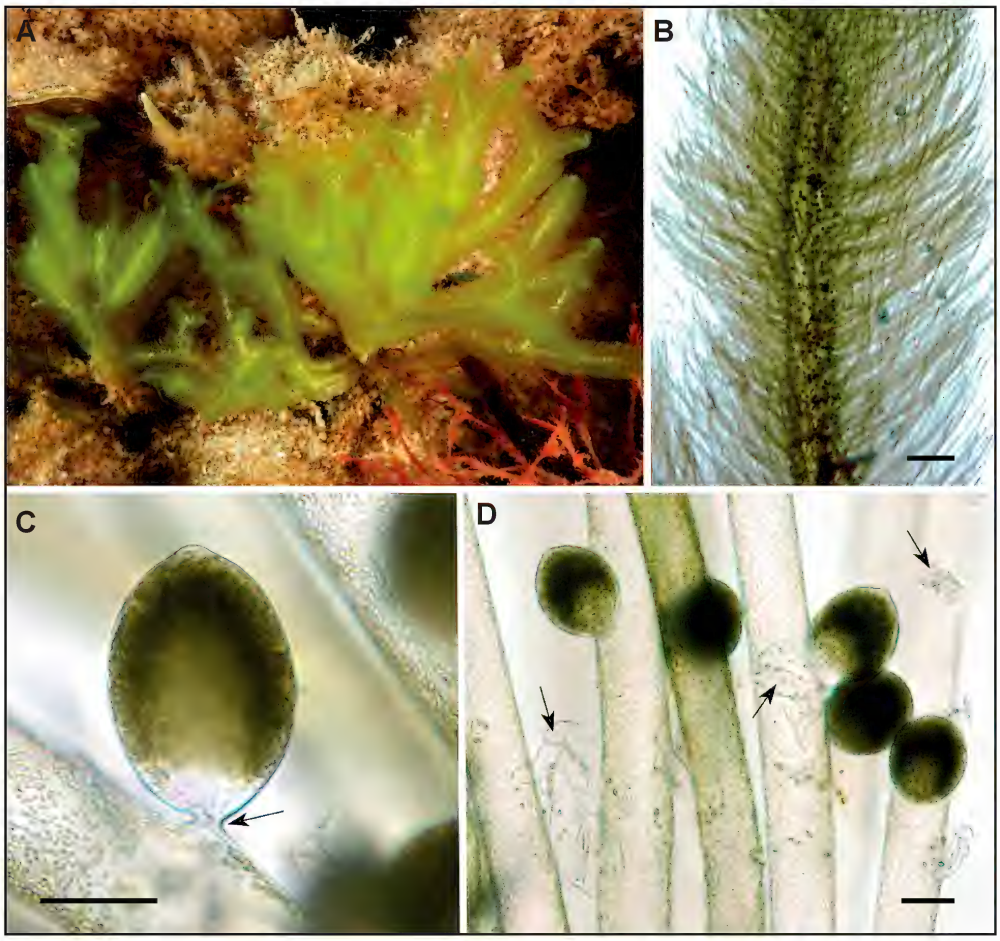

Figure 1. *Pseudobryopsis australis*. A – alga *in situ* showing branched upright axes; B – detail of branch with dense cover of ramelli; C – mature gametangium with occluded base (arrow); D – mature and spent gametangia (arrows), the latter persisting as 'ghost' walls. Scale bars = 1 mm (B); 50 µm (C, D). Images from PERTH 09316752 (A); PERTH 09184651 (B–D). Photographs by J.M. Huisman.

500 m south of Green Is., Rottnest Is., on the reef flat, 4 Dec. 1980, *R. Ricker & G.T. Kraft s.n.* (AD-A 51952); Roe Reef, Rottnest Is., 17 Dec. 2009, *H. Verbruggen* HV02592 (BR [ex GENT]); Groper Canyon, Rottnest Is., 17 Dec. 2009, *H. Verbruggen* HV02620 (BR [ex GENT]).

Phenology. Reproductive specimens have been collected during the austral spring and summer; however, this may reflect preferred conditions for collecting rather than seasonality.

Distribution and habitat. Known from Cape Peron, Rottnest Island, and the Houtman Abrolhos Islands, Western Australia, epilithic in the shallow subtidal.

Conservation status. The species is known from limited collections but is present in the conservation estate and is unlikely to be under direct threat.

Etymology. The epithet is from the Latin *australis* (southern), in reference to the southern hemisphere range of the known specimens.

Notes. *Pseudobryopsis* presently includes eight accepted species, mostly from tropical/subtropical locations in the northern hemisphere (Guiry & Guiry 2025), with only the New Zealand *P. planktonica* Cassie described from a southern hemisphere type locality. It is currently the sole genus in the recently erected family Pseudobryopsidaceae (Cremen *et al.* 2019). In the past it has been regarded as closely related to *Trichosolen* Mont., a genus currently placed in the Bryopsidaceae (Guiry & Guiry 2025) based on morphology but not yet represented in molecular libraries, and as such its true affinities are uncertain. The genera differ in *Pseudobryopsis* having mature gametangia with occluded bases that empty entirely (i.e. do not refill as in *Trichosolen*), and small chloroplasts lacking pyrenoids (Henne & Schnetter 1999). The presence of pyrenoids has been variously reported, with *P. hainanensis* C.K.Tseng described with (Tseng 1936) and without (Kraft 2007) pyrenoids, although both authors seemingly described similar chloroplasts, with the 'transparent bodies' (Tseng 1936) or 'clear central areas' (Kraft 2007) interpreted as pyrenoids by Tseng (1936) but not Kraft (2007). Kobara and Chihara (1978) describe *P. hainanensis* as lacking pyrenoids.

Pseudobryopsis australis displays each of the features regarded as distinguishing *Pseudobryopsis* and is clearly a member of the genus. South-west Australian specimens have previously been identified as *P. hainanensis* (e.g. Huisman 2023) but were re-examined in light of molecular analyses of the *tuf*A and *rbc*L genes (Figure 2), the results indicating that while closely allied, the taxon differs from that species and represents an undescribed species. As described by Tseng (1936), Chinese *P. hainanensis* is a considerably smaller plant, with correspondingly smaller branch diameters and gametangia. Tseng (1936) gave the diameter of primary axes as 500 µm at the base, and that of ramelli as 18–36 µm, whereas primary axes in *P. australis* are up to 1000 µm in diameter and ramelli are mostly 55–60 µm in diameter, only approaching the upper dimension (36 µm) of *P. hainanensis* near the apices. Kobara and Chihara (1978) described their Japanese specimens of *P. hainanensis* as having primary axes to 1000 µm diam., therefore similar to *P. australis*, but the ramuli only reaching 30 µm in diameter, only approaching 50 µm in the lower, inflated portion. It is possible that the specimens attributed to *P. hainanensis* by Kobara and Chihara (1978) represent a different species, but that cannot be ascertained here. Regarding overall dimensions, *P. australis* is similar to the generitype *P. myura* (J.Agardh) Berthold, a Mediterranean species, as described by Feldmann (1969) and Kanaan and Belous (2016). Gametangia in *P. myura* were described by Feldmann as 'showing rather large variations in shape' and gave dimensions of 110–123 µm long and 60–90 µm diameter, agreeing entirely with *P. australis*. However, *P. myura* was described as monoecious, with separate male and female gametangia that can be distinguished by their colour, as the female gametangia are dark green with a tinge of brown-orange due to the presence of a stigma in female gametes, and the male gametangia are a lighter green colour. A similar distinction was noted by Chihara and Kobara (1995). Gametangia in *P. australis* differ in being uniformly dark green. Wynne and Hoffman (2016) however, did not attach any 'great significance' to this apparent difference when they placed *P. papillata* Nasr in synonymy with *P. myura*. Nevertheless, dioecy would appear to be the only morphological difference between *P. myura* and *P. australis* and we have relied primarily on molecular data to distinguish the two species.

The paucity of molecular data for species of *Pseudobryopsis* limit the extent of our analyses; however, they do demonstrate the close relationship of *P. australis* to *P. hainanensis* and *P. oahuensis* Egerod, and more distantly to the generitype *P. myura*. Morphologically, *P. oahuensis* has generally simple primary axes and gametangia are more numerous (up to five per ramulus) and elongate (Egerod 1952; Abbott & Huisman 2004; Huisman *et al.* 2007). There are six species of *Pseudobryopsis* not represented in molecular libraries, of these *P. basiglabra* Cárdenas-Barón, Gavio & M.J.Wynne has gametangia borne directly on the primary axes and not on ramuli (Cárdenas-Barón *et al.* 2025), *P. planktonica* is, as the name suggests, planktonic (Cassie 1969) and should probably be excluded from the genus according to Henne and Schnetter (1999), *P. venezolana* (W.R.Taylor) K.-D.Henne & R.Schnetter has gametangia in series of 3–7 per ramulus (Taylor 1962, as *Trichosolen*), *P. blomquistii* Díaz-Piferrer is reported to have pyrenoids (Díaz-Piferrer 1965), although this was disputed by Henne and Schnetter (1999) who examined an isotype and found it to have extremely small chloroplasts that 'definitely lacked a pyrenoid', nevertheless, *P. blomquistii* has shorter and narrower ramuli than *P. australis*. Lastly, *P. thikkodiensis* Anil Kumar & Panikkar is reported to have pyrenoids (Anil Kumar & Panikkar 1993) and illustrations in the

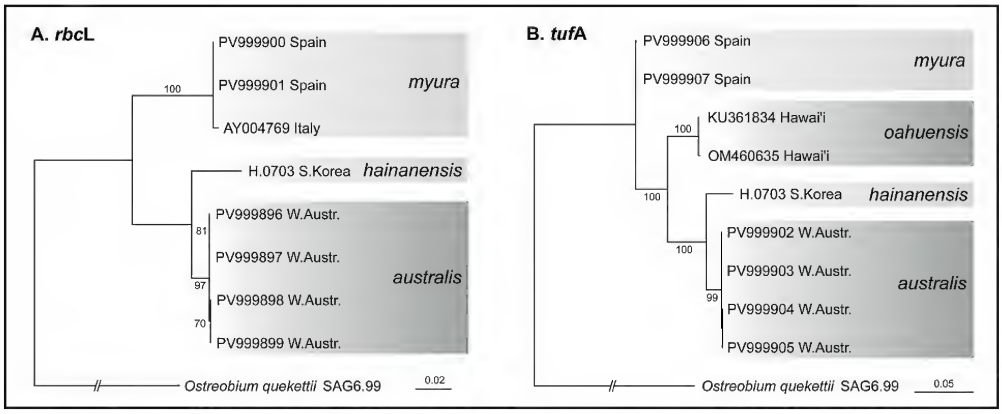

Figure 2. Molecular phylogenies of the *rbc*L (A) and *tuf*A (B) genes. Samples were subjected to high-throughput sequencing as described in Huisman *et al.* (2024) and the relevant gene sequences extracted and used alongside relevant reference sequences from GenBank to infer phylogenies with IQ-Tree 2.1.4 (Minh *et al.* 2020) using a GTR+I+G model and 1000 ultrafast bootstraps (shown if >70%). GenBank accession numbers PV999898, PV999904 = PERTH 09183507 (holotype) and PV999897, PV999905 = PERTH 09316752.

protologue suggest it has gametangia in open connection with the bearing branch, indicating it may be better placed in *Trichosolen*. Of the species currently in synonymy, *P. papillata*, treated as a taxonomic synonym of *P. myura* by Wynne and Hoffman (2016), differs in its smaller gametangia (Nasr 1944).

We are attributing south-western Australian specimens to the new species *P. australis*; however, we cannot with any certainty (lacking molecular data) ascertain the identities of two tropical specimens (PERTH 07150091 and an unaccessioned slide preparation) recorded as *P. hainanensis* by Huisman (2015). These were vegetatively smaller (primary axes to 500 µm diam., ramuli to 25 µm diam.) but with gametangia that are comparable in dimensions to those of *P. australis* but proportionally more elongate (see Huisman 2015: Fig. 11G). Further study incorporating molecular analyses of Australian tropical specimens and other potentially misidentified specimens (e.g. the *P. hainanensis* of Kobara and Chihara 1978 and Kraft 2007) is required.

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Synonymisation of *Verticordia spicata* subsp. *squamosa* under *V. spicata* (Myrtaceae) based on molecular and morphological evidence

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SHORT COMMUNICATION

Verticordia spicata subsp. *squamosa* A.S.George was described by George (1991) to distinguish a rare, geographically disjunct entity with smaller floral and leaf features from the more widespread *V. spicata* F.Muell. subsp. *spicata*. Subsequently, subsp. *squamosa* was declared as Rare Flora in 1995 and it remains listed as Critically Endangered under the current Western Australian *Biodiversity Conservation Act 2016* due to the very small area of occurrence, very low number of individuals and ongoing decline (Stack *et al*. 2004; State of Western Australia 2024). However, a recent assessment of the since expanded collections of these taxa has demonstrated that the geographic separation between the two subspecies has been considerably overestimated, that the few diagnostic characters between the two subspecies are not discrete but continuous and overlapping, and that there is similar or greater morphological and molecular variation within subsp. *spicata* than there is between the two subspecies (Bradbury *et al*. 2025). As such, there is no taxonomic basis for continuing to recognise *V. spicata* subsp. *squamosa* as a separate taxon and, consequently, also no basis for its conservation listing. Here we synonymise subsp. *squamosa* under *V. spicata* to form a single species that is common in the coastal Midwest region of Western Australia.

Verticordia spicata F.Muell., *Fragm.* 1(10): 226 (1859); *Verticordia spicata* A.S.George subsp. *spicata*, *Nuytsia* 7(3): 368 (1991). *Type*: 'Ad flumen Murchison in locis apricis. A. Oldfield' [Murchison River, Western Australia 1856–1859, *A.F. Oldfield s.n.*] (*lecto*: K 000843393 image!, designated by A.S. George, *Nuytsia* 7(3): 368 (1991); *isolecto*: BM *n.v.*).

Verticordia spicata subsp. *squamosa* A.S.George, *Nuytsia* 7(3): 368–369 (1991). *Type*: '7.2 km E of Three Springs–Morawa road along Simpson Road, Western Australia, c. 29° 24' S, 115° 50' E,', 30 December 1981, *C. Chapman* 42 (*holo*: PERTH 01887831!; *iso*: CANB 425689 image!, K 000843392 image!).

Illustrations. E. Pritzel, *Bot. Jahrb. Syst.* 35: 406, Figure 48A–C (1904); W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* 3A: 27 (1980); E.A. George & A.S. George, *Nuytsia* 9(3): 338, Figure 2D, G, J (1994); E.A. George & M. Pieroni, *Verticordia: the turner of hearts* 355 & 357, Plate 83A, B (2002).

Shrub 0.3–2 m high, 0.2–1.5 m wide, without a lignotuber. *Petioles* ± absent. *Leaf blades* ovate-elliptic to very broadly ovate, 2–3.5 mm long, 1.2–2.5 mm wide, ciliolate; apical point ± absent. *Peduncles* mostly borne at 6–27 consecutive nodes, 0–0.2 mm long, the spike-like inflorescence up to 55(–70) mm long. *Bracteoles* persistent in flower and sometimes in fruit, 3.5–4.5 mm long, with a dorsal point 0.4–1.3 mm long. *Flowers* 8–13 mm diam. *Hypanthium* with 5 antipetalous ribs separated by 5 large appendages, the overall shape (including appendages) pentagonal in cross-section, 1.7–2.3 mm long, glabrous, honeycombed (i.e. reticulate-pitted); appendages antisepalous, reflexed onto hypanthium and concealing most of it, narrowly obtriangular or obtriangular, 1.6–2 mm long, green. *Sepals* 3–5.5 mm long, pink;

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lobes 6 or 7; auricles very narrow and with long narrow divisions, *c.* as long as the hypanthium and largely concealing the antipetalous ribs. *Petals* inserted 0.4–0.5 mm above the sepals, 2.5–4.5 mm long, pink, conspicuously fringed, without auricles; fringe 1–2 mm long. *Stamens* 10, united to staminodes at base and of a similar length to them. *Anthers* ± oblong from front view, 0.45–0.6 mm long, dehiscent by longitudinal slits, deep pink; connective gland large. *Staminodes* 10, triangular to subulate, 1.5–1.7 mm long, glandular-verrucose. *Ovules* usually 6, rarely 7. *Style* exserted, usually sigmoid distally and gently curved below, 4–9 mm long; substigmatic hairs 0.3–0.4 mm long, in a cylindrical zone 1–1.5 mm long, with some of the hairs branched; stigma capitate, *c.* 0.1 mm diam. *Fruits* 1.5–1.8 mm high, 2–2.6 mm across; seed star-shaped (5-pointed) from top view, 1–1.2 mm high, 1.2–1.35 mm across.

Selected specimens examined. WESTERN AUSTRALIA: N of Kalbarri National Park, W of Eurardy Station, 28 Oct. 2024, *B. Anderson & K.J. Sadgrove* BMA 343 (PERTH); Colgate Rd, 6 Nov. 2019, *A. Chant* AC 3058 (PERTH); 4 km NE along Three Springs–Morawa road from Verral Road, 3 Dec. 1995, *E. Holland & F. Bunny* EH 616 (PERTH); Indarra Springs Nature Reserve, 13 Nov. 2019, *J. Jackson & K. Dodd* 411 (PERTH); Coolcalalaya Station, 29 Oct. 1991, *G.J. Keighery* 14743 (PERTH).

Distribution and habitat. Extends for *c.* 300 km, from near Zuytdorp Nature Reserve south-east to near Three Springs, usually in yellow sand, in species-rich shrublands that are often dominated by scattered tall shrubs or trees in the genera *Allocasuarina*, *Banksia*, *Callitris*, *Eucalyptus* or *Grevillea*.

Conservation status. Not currently considered to be at risk in Western Australia (Western Australian Herbarium 1998–).

Phenology. Flowers from October to January, with fruits recorded from November and January.

Vernacular name. Spiked Featherflower.

Chromosome number. $n = 11$ (Tyagi *et al.* 1991).

Affinities. George (1991) placed *V. spicata* in section *Verticordella* Meisn. of *Verticordia* subgenus *Eperephes* A.S.George but the species is atypical of this section in its persistent bracteoles, long sepal auricles and northern distribution. Molecular data (Matt Barrett pers. comm.) indicate that *V. spicata* should be transferred to sect. *Pennuligera* Meisn., which it matches in having persistent bracteoles. However, it is also somewhat atypical of sect. *Pennuligera* in the different shape of its reflexed auricles, which are very narrow and only cover the antipetalous ribs rather than the whole hypanthium.

Further evidence that *Verticordia spicata* should be transferred is that it is reported to hybridise with *V. comosa* A.S.George, *V. dichroma* A.S.George and *V. fragrans* A.S.George of sect. *Pennuligera* but not with any members of sect. *Verticordella* (George 1991; George & George 1994; George & Pieroni 2002). *Verticordia spicata* and one further species of sect. *Pennuligera*, *V. chrysostachys* Meisn., are also recorded as parents for a single putative hybrid specimen (*J. Docherty* 494) at PERTH.

The most recent key to sect. *Pennuligera* (George & Pieroni 2002: 97–98) is updated below to incorporate the additional species, *V. spicata*, and various new information for other taxa.

Key to members of *Verticordia* sect. *Pennuligera*

1. Mature style 10–25 mm long. Sepals bright red or silver and purple

2. Petals digitately lobed, purple. Sepals purple with silver lobes. Substigmatic zone including some branched hairs (Kalbarri NP–Wandana NR) ..... **V. oculata**

2: Petals dentate or fimbriate, creamish red to bright red. Sepals bright red. Substigmatic hairs all simple

3. Leaves 8–15 mm long. Petals dentate. Mature style 20–25 mm long (S of Eneabba–Badgingarra area) ..... **V. grandis**

3: Leaves 2–6.5 mm long. Petals fimbriate. Mature style 10–20 mm long

4. Leaf blades (3.5–)4–6.5 mm long. Peduncles 6–10 mm long. Sepals (7.5–)8–10 mm long. Mature style usually 16–20 mm long (Meadow Stn–Kalbarri NP) ..... **V. etheliana** var. **etheliana**

4: Leaf blades 2–3(–4.5) mm long. Peduncles 3–6(–8) mm long. Sepals 7–8(–9) mm long. Mature style usually 12–16 mm long (Kalbarri NP area–near Mullewa) ..... **V. etheliana** var. **formosa**

1: Mature style 4–9 mm long. Sepals pink to maroon, white or yellow.

5. Sepals with long slender auricles that only cover part of the hypanthium. Petals lacking auricles (near Zuytdorp NR–Three Springs area) ..... **V. spicata**

5: Sepals with broad peltate auricles that cover the whole hypanthium. Petals with small auricles

6. Staminodes channelled, ± narrowly oblong, dentate or 3-lobed, not particularly glandular (glands few, widely spaced and/or not very prominent)

7. Substigmatic hairs in a lateral tuft. Petals with a fringe 0.6–1.1 mm long (Three Springs–Morawa) ..... **V. comosa**

7: Substigmatic hairs in a cylindrical zone. Petals entire or with a fringe up to 0.8 mm long

8. Sepal lobes broad throughout, plumose (S of Eneabba) ..... **V. fragrans**

8: Sepal lobes narrow and tapering distally, fimbriate

9. Petals maroon, fringed distally with hairs 0.4–0.8 mm long (S of Wicherina) ..... **V. muelleriana** subsp. **minor**

9: Petals cream to mid yellow or pinkish, entire or shortly fringed distally with hairs less than 0.4 mm long

10. Sepals 3.5–4.5 mm long, divided for *c.* 2/3 their length into long-ciliate lobes. Petals dentate or erose at least on lateral margins (Kalbarri–Mullewa area) ..... **V. lepidophylla** var. **lepidophylla**

10: Sepals 2–2.5 mm long, divided for less than 1/2 their length into ciliate lobes or simple with a dentate margin. Petals entire distally, denticulate towards the base (Zuytdorp–Nerren Nerren area) ..... **V. lepidophylla** var. **quantula**

6: Staminodes linear-subulate, entire, usually with prominent glands that are densely grouped distally or in some other position

11. Sepals 8–9 mm long. Mature style *c.* 8 mm long (Cape Range NP) ..... **V. serotina**

11: Sepals 4–6 mm long. Mature style 4.5–7 mm long

12. Style with a cylindrical zone of substigmatic hairs or with hairs concentrated on the inner surface of a sigmoid curve

13. Substigmatic hairs 0.15–0.4 mm long

14. Leaves 5–9 mm long, 7–10 mm wide (S of Eneabba) ..... **V. argentea**

14: Leaves 3–4 mm long, 2.5–3 mm wide (Perenjori–Wongan Hills–Bencubbin) ..... **V. venusta**

13: Substigmatic hairs 0.5–1.2 mm long

15. Leaves 6–9 mm wide. Sepals dark pink to maroon (Coorow–Watheroo) ..... **V. muelleriana** subsp. **muelleriana**

15: Leaves 1.5–4.5 mm wide. Sepals white or pale pink (SW of Three Springs) ..... **V. albida**

12: Style with substigmatic area strongly curved and with hairs concentrated on the outer surface, forming a lateral tuft

16. Flowers pink to maroon throughout

17. Leaves entire or with teeth that are just marginal to a broad, thin border around blade. Petals deep magenta to maroon. Occurring south of Shark Bay (Eurardy Stn) ..... **V. × eurardyensis**

17: Leaves usually with teeth that ± reach the thickened part of blade. Petals pale to deep pink. Occurring north of Shark Bay (Onslow–Carnarvon–Wooramel River area) ..... **V. forrestii**

16: Flowers yellow throughout or partially yellow

18. Flowers pale to deep yellow throughout

19. Peduncles 2.5–4 mm long. Petals golden yellow, 6–7 mm long, including a fringe of obtuse segments 2–3.5 mm long. Substigmatic hairs 0.2–0.3 mm long (Kalbarri NP area–near Mullewa) ..... **V. chrysostachys** var. **chrysostachys**

19: Peduncles 1.3–3 mm long. Petals pale yellow, 4.5–6 mm long, including a fringe of acute segments (0.5–)1–2(–2.5) mm long. Substigmatic hairs 0.3–0.6 mm long (Kalbarri NP area–S of Morawa) ..... **V. chrysostachys** var. **pallida**

18: Flowers 2-toned with both yellow and maroon to bronze

20. Substigmatic hairs 0.15–0.25 mm long. Peduncles 2.5–5.5 mm long (NE of Yuna) ..... **V. aereiflora**

20: Substigmatic hairs 0.7–0.9 mm long. Peduncles 1.5–2(–3) mm long

21. Leaves commonly strongly reclinate or recurved; blade usually 3–4 × 2.5–4 mm. Flowers often 12 or more per cluster. Petals 5–7 mm long; fringe 2–3.5 mm long (Kalbarri NP area) ..... **V. dichroma** var. **dichroma**

21: Leaves rarely strongly reclinate or recurved; blade usually 2–3 × 1.7–3 mm. Flowers often fewer than 10 per cluster. Petals 4–6 mm long; fringe 1.5–2 mm long (W of Billabong–Kalbarri NP) ..... **V. dichroma** var. **syntoma**

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Three new species of *Eremophila* (Scrophulariaceae) from the goldfields of Western Australia

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SHORT COMMUNICATION

Eremophila isolata Buirchell, *sp. nov.*

Type: West of Plumridge Lakes, Western Australia [precise locality withheld for conservation reasons], 1 June 2014, *B. Buirchell* BB323 (*holo*: PERTH 08656711; *iso*: AD, MEL).

Eremophila sp. Tropicana (B. Buirchell BB323), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 8 October 2024].

Illustrations. A.P. Brown & B.J. Buirchell, *A field guide to the Eremophilas of Western Australia revised second edition* p. 343 (2021), as *E.* sp. Tropicana.

A small much-branched *shrub* 0.4–0.6 m high, 0.5–1.0 m wide. *Branches* terete, non-tuberculate, with indumentum of white eglandular hairs. *Leaves* blue-green, alternate; *lamina* linear-oblanceolate, 5–9 mm long, 1.5–2.5 mm wide with an indumentum of white eglandular hairs; margins entire; apex obtuse. *Flowers* 1 per axil; pedicel terete, straight, 2–4 mm long, with an indumentum of white eglandular hairs. *Sepals* 5, green, narrow-lanceolate, 7–8 mm long, 0.5–1.0 mm wide, acute, attenuate, equal, half the length of the corolla, not enlarging after flowering; outer surface with an indumentum of long white eglandular hairs, becoming shorter near the apex, intermixed with short glandular hairs; inner surface with an indumentum of eglandular and glandular hairs. *Corolla* zygomorphic, 12–14 mm long, mostly purple, pale underneath; medial lobe of lower lip thrust up between lateral lobes and closing the throat; outer surface with indumentum of eglandular hairs; inner surface glabrous; throat hairy, especially on the upper surface; inner surface of corolla tube covered in purple spots. *Stamens* 4, enclosed, filaments glabrous, anthers glabrous. *Ovary* indumentum of eglandular hairs mixed with short glandular hairs. *Style* with eglandular hairs. *Seeds* not observed. (Figure 1)

Diagnostic features. *Eremophila isolata* may be distinguished from all other members of the genus by the following combination of characters: a small much branched shrub 0.4–0.6 cm high; leaves green, linear-lanceolate with an indumentum of white eglandular hairs; pedicel 2–4 mm long, with an indumentum of white eglandular hairs; sepals narrow-lanceolate, 7–8 mm long, 0.5–1.0 mm wide, corolla zygomorphic, outer surface mostly purple with medial lobe of lower lip thrust up against the lateral lobes and closing the throat; ovary with long eglandular hairs mixed with short glandular hairs.

Other specimens examined. Known only from the type.

Phenology. Known to flower in June but may flower at other times in response to significant rainfall.

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Figure 1. *Eremophila isolata*. A – habit; B – flowering branch showing the blue-green hairy leaves, hairy narrow sepals, and purple corolla with white on the lower lobes; C – habitat (*E. isolata* in the foreground). Photographs by B.J. Buirchell.

Distribution and habitat. Known from a single location in the Great Victoria Desert west of Plumridge Lakes, growing in orange-red sandy loam soils in an open tall shrubland of *Eremophila platythamnos* subsp. *platythamnos*, *E. scoparia*, *Eucalyptus hypolaena* and scattered *Senna*, *Acacia*, *Halgania* and *Triodia* species. The area has been extensively searched using nearby accessible tracks and no further populations have been located.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–) under the name *E.* sp. Tropicana (B. Buirchell BB 323). The species is currently known from a single site and may have specific habitat requirements. Further surveys are required in the area, which is under threat from mining exploration and other mining activities.

Etymology. The specific epithet is derived from the Latin *isolatus* (isolated), referring to its remote and restricted habitat and distribution.

Affinities. The species is related to *Eremophila perglandulosa* Chinnock, *E. battii* F.Muell. and *E. spinescens* Chinnock but may be distinguished from all of these in having only eglandular hairs rather than a mix of glandular and eglandular hairs on the leaves and pedicels.

Eremophila serotina Buirchell & A.P.Br., *sp. nov.*

Type: West side of track, *c.* 3.8 km SSE of North West Peak, Mt Manning Range, Western Australia, 6 November 1995, *N. Gibson* & *B. Moyle* 3402 (*holo*: PERTH 05325153; *iso*: AD, CANB, MEL).

Eremophila sp. Mt Jackson (G.J. Keighery 4372), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 31 October 2024].

Illustrations. A.P. Brown & B.J. Buirchell, *A field guide to the Eremophilas of Western Australia revised second edition* p. 334 (2021) as *E.* sp. Mt Jackson.

Broom like *shrub* 2–5 m high, *c.* 1.5 m wide. *Branches* glandular-papillate, warty, resinous. *Leaves* 18–45 mm long, 0.8–1.2 mm wide, green, linear, terete, ventrally grooved, uncinate, glabrous, warty. *Flowers* 1–4 per axil, pedicels ridged, resinous, 3–4 mm long, curved, glabrous. *Sepals* valvate, resinous, 2.4–3.5 mm long, 0.5–1 mm wide, linear-oblanceolate, acute; outer surface glandular-papillate, ciliate with eglandular hairs; inner surface glabrous. *Corolla* zygomorphic, 9–12 mm long, white to pale pink; outer surface with indumentum of short glandular and longer eglandular hairs; margins of lobes covered in longer eglandular hairs, the inner surfaces of the lowermost lobe and the tube below it and around the filament bases villous with eglandular hairs, otherwise glabrous. *Stamens* 4 enclosed; filaments glabrous; anthers glabrous. *Ovary* indumentum of sparse short glandular and longer eglandular hairs. *Style* indumentum of scattered eglandular hairs with denser glandular hairs near base. (Figure 2)

Diagnostic features. *Eremophila serotina* may be distinguished from all other members of the genus by the following combination of characters: stems and leaves warty; leaves ventrally grooved, uncinate, glabrous; sepals linear-lanceolate, glabrous; corolla with short glandular and long eglandular hairs; ovary with short glandular and a scattering of longer eglandular hairs.

Other specimens examined. WESTERN AUSTRALIA: 1 km N of I261 Diemals Stn, 1 Dec. 1992, *D.A. Blood* 3374 (PERTH 04220811); between Portman Iron ore haul road and Marda Tank area on Mt Jackson Stn, S of Mt Jackson, 3 Nov. 2004, *V. Clarke* 533 (PERTH 08091986); 46 km NNE of Kalgoorlie, adjacent to Goldfields Hwy, 30 Oct. 2006, *G. Cockerton & D. True* WB 12808 (PERTH 08630836); Mt Jackson, 25 Nov. 1981, *G.J. Keighery* 4372 (PERTH 03900630); Johnston Ra, adjacent to survey site DIEM05, on Diemals Stn, *c.* 4.3 km SW of Teds Camp Bore and 6.1 km ENE of Diemals Homestead, *c.* 149 km N of Bullfinch, 4 Aug. 2007, *A. Markey & S. Dillon* 5821 (PERTH 07839073); Northern Yerilgee Greenstone Belt, Lake Giles East, survey site GILE48, *c.* 21.2 km SE of Johnson Soak and 2.3 km N of spot height 508 m, *c.* 106 km WSW of Menzies, 29 Sep. 2007, *A. Markey & S. Dillon* 6104 (PERTH 07838719); Northern Yerilgee Greenstone Belt, Lake Giles East, survey site GILE40, *c.* 19.9 km ESE of Johnson Soak and 8.7 km NNE of spot height 508 m, *c.* 102 km W of Menzies, 27 Sep. 2007, *A. Markey & S. Dillon* 6105 (PERTH 07838727); Northern Yerilgee Greenstone Belt, Lake Giles East, survey site GILE21, *c.* 9.9 km NNE of Johnson Soak and 6 km W of spot height 477 m, *c.* 113 km W of Menzies, 23 Sep. 2007, *A. Markey & S. Dillon* 6106 (PERTH 07838735); Mt Jackson, 4 Nov. 2000,

Figure 2. *Eremophila serotina*. A – habitat (*E. serotina* in the foreground); B – flowering branch showing the white to pale pink flowers and small sepals. Photographs by A. Brown.

E. Mattiske 178-328 LM (PERTH 06351131); Jackson Ra, N of Marda Dam, 16 May 2004, *S. McNee* LCS 14310 (PERTH 08035024); Credo Stn, 4 Nov. 1988, *H. Pringle* HP2224 (CANB 511915, PERTH 03856631); Ora Banda, 4 Nov. 2005, *E. Reid* s.n. (PERTH 07308868); Grants Patch Mine, 4 Nov. 2005, *E. Reid* s.n. (PERTH 07308876); 57 km S of Menzies, 18 Sep. 1999, *R.T. Schuh, G. Cassis & R. Silveira* 40 (PERTH 05612624); 32.8 km SSE of Goongarrie Stn, 16 Jan. 2008, *J. Williams* 8 (PERTH 07881584).

Phenology. Flowers October to December.

Distribution and habitat. Found from the Mt Jackson area eastwards to north of Kalgoorlie, growing in red clay, greenstone gravel or brown calcareous loams in open mixed woodland of *Eucalyptus* species over *Exocarpos aphyllus*, *Olearia muelleri* and *Acacia* species.

Conservation status. Not considered at risk. An abundant species in its known habitat, although growing in a region subject to mining activities.

Etymology. The specific epithet is derived from the Latin *serotinus* (late coming), referring to the late flowering period compared to most other *Eremophila* species in the Goldfields.

Affinities. *Eremophila serotina* is related to *E. interstans* (S.Moore) Diels but may be distinguished from that species by its warty branches (*cf.* lacking warts), a mixture of eglandular and glandular hairs on the corolla (hairs eglandular only) and short glandular hairs mixed with sparse, longer eglandular hairs on the ovary (*cf.* glabrous). It is also related to *E. paisleyi* F.Muell but has narrower leaves 0.8–1.2 mm wide (*cf.* 1.1–5 mm wide) and a hairy ovary (*cf.* glabrous). From the also related *E. caperata* Chinnock, *E. serotina* may be distinguished by its glabrous leaves (*cf.* hairy) and its linear lanceolate sepals (*cf.* obovate to cuneate).

Eremophila lasiocarpa Buirchell, *sp. nov.*

Type: Lake Carey, Western Australia [precise locality withheld for conservation reasons], 14 October 2018, *E. Mattiske* LM197 (*holo*: PERTH 09089977; *iso*: AD).

Eremophila sp. Lake Carey (E. Mattiske LM197), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 8 October 2024].

Erect broom-like *shrub* 1–2 m high, 0.5–2 m wide. *Branches* grey or light brown, erect, terete, glabrous, with tubercles arranged in rows below leaf bases, especially on younger parts. *Leaves* light green, alternate, petiolate, thickened, v-shaped in cross section or with a deep adaxial groove, mucronate, glabrous; *lamina* linear to oblanceolate 7–12 mm long, 0.8–1.8 mm wide, margins entire. *Flowers* 1–2 per axil, pedicellate; pedicel terete, 3–5 mm long, glabrous, light green. *Sepals* 5, green with a pink tinge, imbricate, subequal, oblanceolate, 5–6 mm long, 1.5–2.5 mm wide, obtuse; outer surface mostly glabrous but with an indumentum of eglandular hairs on the margins; inner surface with indumentum of glandular hairs. *Corolla* zygomorphic, 8–11 mm long, pale cream to pink, unspotted; outer and inner surfaces covered in fine eglandular hairs. *Stamens* 4, enclosed; filaments glabrous; anthers glabrous. *Ovary* villous, covered with erect long eglandular hairs. S*tyle* glabrous. *Seeds* not observed. (Figure 3)

Diagnostic features. *Eremophila lasiocarpa* may be distinguished from all members of the genus by the following combination of characters: an erect broom like shrub to 2 m high; leaves thickened, linear to oblanceolate, v-shaped in cross section or with a deep adaxial groove, 7–12 mm long; sepals imbricate, subequal, oblanceolate, green with a pink tinge; corolla pale cream to pink covered with eglandular hairs; ovary villous with erect, long, eglandular hairs; style glabrous.

Other specimens examined. WESTERN AUSTRALIA. [localities withheld for conservation reasons] 25 Oct. 2020, *A. Dent* BW016 (PERTH 09288422); 25 Oct. 2020, *A. Dent* BW017 (PERTH 09288414); 11 Oct. 2018, *E. Mattiske* LM049 (PERTH 09089985); 15 Oct. 2009, *A.A Mitchell, A.L. Payne & A. McR. Holm* 9369 (PERTH 09464506).

Phenology. Known to flower in September and October but may flower at other times in response to significant rainfall.

Distribution and habitat. Found on the lower slopes of hills on the western side of Lake Carey, north-east of Kalgoorlie. Growing in red clay loam soils with rocky surface in sparse vegetation dominated by *Eremophila lasiocarpa* and including *Acacia aneura* and chenopods.

Conservation status. Listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–) under the name *E*. sp. Lake Carey (E. Mattiske LM197). Only known from a few collections in an area subject to mining and mining exploration.

Etymology. The specific epithet is derived From the Greek *lasio-* (hairy, woolly) and *-carpus* (-fruited), in reference to the long hairs on the fruit.

Affinities. *Eremophila lasiocarpa* is related to *E. micrantha* Chinnock, *E. paisleyi* Chinnock and *E. falcata* Chinnock but may be distinguished from *E. micrantha* by its shorter leaves 7–12 mm long (*cf.* 18–25 mm long), its longer oblanceolate sepals 5–6 mm long (*cf.* lanceolate and 1.6–3 mm long) and longer pale cream to pink corolla 7–12 mm long (*cf.* white and 5–6.5 mm long). From *E. paisleyi* and *E. falcata* it may be distinguished by its shorter leaves 7–12 mm long (*cf.* 21–46 mm long and 19–31 mm long, respectively) and the lack of glandular hairs on the corolla and ovary.

Figure 3. *Eremophila lasiocarpa*. A – plant and habitat (*E. lasiocarpa* in the foreground); B – post-flowering plant showing the thickened leaves and fruit and the villous ovaries: C – an herbarium specimen indicating a flowering branch. Photographs by B.J. Buirchell.

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Goodenia jabailyae and *Scaevola goodsiorum* (Goodeniaceae), two new species from the Mallee bioregion of Western Australia

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SHORT COMMUNICATION

The discovery of undescribed, narrow range, endemic species still occurs with surprising frequency in Western Australia. The two species of Goodeniaceae named and described herein as *Goodenia jabailyae* K.A.Sheph. & L.W.Sage and *Scaevola goodsiorum* R.W.Davis, K.A.Sheph. & L.W.Sage were collected for the first time in 2006 and 2017 respectively. Both species are currently only known from a single population situated *c.* 45 km apart in the Mallee bioregion of southwest Western Australia and hence are species of conservation concern.

Goodenia jabailyae K.A.Sheph. & L.W.Sage, *sp. nov.*

Type: southeast of Clyde Hill Nature Reserve, Western Australia, [precise locality withheld for conservation reasons], 2 October 2020, *K.A. Shepherd & C.F. Wilkins* KS 1777 (*holo*: PERTH 09815368; *iso*: CANB, K, MEL, NY).

Small prostrate annual *herb*, 5.5–17 cm wide, with strigose and simple hairs. *Leaves* in a basal rosette, narrowly obovate to oblanceolate, gradually narrowing basally, pinnatifid with linear to narrowly ovate lobes in the upper two thirds; lamina (including petiole) 8–31 mm long, 0.9–6 mm wide, lobes 1.4–3 mm long, 0.3–2.1 mm wide, with scattered strigose hairs 0.2–0.5 mm long, apex rounded to acute. *Inflorescence* with solitary flowers or a 2–3-flowered raceme, 30–80 mm long; peduncles 40–78 mm long, with scattered, simple hairs and strigose hairs, 0.3–0.4 mm long; pedicels 9–35 mm long, articulation line absent, hairs similar to peduncles, becoming denser towards the apex; bracts leaf-like, positioned at pedicel base, narrowly elliptic to narrowly ovate or pinnatisect, 4.3–10.1 mm long, 1.8–3.6 mm wide, with strigose hairs 0.4–0.8 mm long, apex subacute to acute; bracteoles absent. *Sepals* very narrowly lanceolate to narrowly elliptic, 1.4–2.9 mm long, 0.3–0.7 mm wide, adnate to *c.* ¾ of the ovary, with scattered simple hairs and white or yellow strigose hairs 0.1–0.5 mm long, apex acute. *Corolla* yellow with reddish-brown markings at base of adaxial lobes, 9.7–10.3 mm long, not articulate; tube 0.8–1.1 mm long, pouch obscure, not exceeding ovary, 0.8–1.2 mm long, *c.* 0.6 mm wide; outer surface with moderately dense, simple and strigose hairs, 0.1–0.3 mm long, inside surface with retrorse, simple hairs inside throat, base glabrous. *Abaxial corolla lobes* 2.5–3.9 mm long, 1.3–1.9 mm wide, fused for 2.6–4.2 mm beyond the junction with the adaxial lobes, distinct from the wings, apex acute; wings 3–4.2 mm long, 1–1.9 mm wide, extending 1.1–1.3 mm beyond the apex of the lobe, with entire margins. *Adaxial corolla lobes* 3.8–6.3 mm long, 0.9–1.6 m wide, fused for a further 0.9 mm; auricle cup-like and prominent, 1.5–2.2 mm long, 0.9–1.4 mm wide; wings almost equal, wing opposite auricle 3 mm long, 1.6–1.8 mm wide, wing above auricle 2.6 mm long, 1.3–2.0 mm wide, extending 1.2 mm

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beyond the apex of the lobe, with entire margins and a line of simple hairs along the point of attachment to lobe. *Stamen* filaments linear, 1.4–2.0 mm long; anthers narrowly oblong to linear, 0.4–1.1 mm long, 0.3–0.4 mm wide. *Ovary* 1.2–1.3 mm long, obovoid, outer surface with moderately dense simple hairs 0.1–0.5 mm long, inner surface with a tuft of hairs at the base, septum obsolete, ovules 9 or 10 attached at base. *Style* 1.8–2.3 mm long, with scattered simple hairs 0.1–0.3 mm long towards the apex only; indusium broadly ovate, 1–1.7 mm long, 1.4–2 mm wide, outer surface with moderately dense simple hairs to 0.3 mm long mixed with short thicker hairs to 0.1 mm long, inner surface with a few simple hairs 0.3–0.5 mm long towards the base only, lips with more or less equal white and purple bristles 0.1–0.2 mm long. *Fruit* an ellipsoid capsule, glabrous, 3.2–3.4 mm long, 3.1–3.2 mm wide. *Seeds* flat, pale green to dark brown, smooth or with faint striations, 1.5 mm long, 1.3 mm wide, wing cream, 0.2–0.3 mm wide overlapping seed margin. (Figure 1)

Diagnostic features. Distinguished from related species allied to *Goodenia pinnatifida* Schltdl. by the following combination of characters: prostrate herb with simple and strigose hairs on the leaves, inflorescence and sepals; corolla 9.7–10.3 mm long, yellow with reddish-brown markings around the throat, with moderately dense simple and strigose hairs 0.1–0.5 mm long on the outer surface; adaxial

Figure 1. *Goodenia jabailyae*. A – habitat; B – habit, low-lying plant *in situ*; C – close up of whole plant highlighting narrow sepals on a flower bud (red arrow); D – pinnatifid leaves; E – yellow flower with a reddish-brown base to the adaxial lobes, which have almost equal wings. Images by K.A. Shepherd (*K.A. Shepherd & C.F. Wilkins* KS 1777).

corolla lobe wings almost equal; ovary with an obsolete septum, ovules 9 or 10, basally attached; and seeds with the wing overlapping the seed margin.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 5 July 2006, *R. Davis* 11113 (PERTH 07362366).

Phenology. Flowering specimens were collected in July.

Distribution and habitat. Found growing in shallow brown clayey sand near exposed granite associated with species of moss and *Drosera*.

Conservation status. As this species is currently only known from a single population, it is to be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.).

Etymology. This delicate new species is named in honour of our dear friend and colleague Dr Rachel S. Jabaily (1982–), Associate Professor at Colorado College (Colorado Springs, USA) (https://orcid.org/0000-0002-4218-3533), in recognition of her significant contribution to plant conservation through her research on Goodeniaceae and Bromeliaceae. Rachel is a passionate educator, teaching a wide range of courses in biogeography, phylogenetics, evolution and field biology and has provided support and guidance to many students throughout her career. A productive collaboration, spearheaded by Rachel and KAS through a National Science Foundation grant (2014–16), has resulted in a wide range of publications that have helped improve our understanding of the evolutionary history and generic boundaries in Goodeniaceae (Berger *et al.* 2017, Gardner *et al.* 2016a, Gardner *et al.* 2016b, Jabaily *et al.* 2012, Jabaily *et al.* 2014, Jabaily *et al.* 2018, Shepherd *et al.* 2017, Shepherd *et al.* 2020).

Affinities. Analyses of *trnL-F* and ITS molecular data (R. Jabaily, unpublished) confirmed that *G. jabailyae* is genetically distinct, and most closely related to *G. pinnatifida*. It can be distinguished from this species by its smaller flowers (10–10.3 mm long vs 13–21 mm long), almost equal wings on the adaxial corolla lobes (vs uneven and narrow wing above the auricle), outer corolla with moderately dense simple and strigose hairs (vs glabrous), and orbicular ovary with an obsolete septum, 9 or 10 basally-attached of ovules (vs septum 2/3 length of the ovary, and 20 ovules in two rows).

Despite being most closely related to *G. pinnatifida*, *G. jabailyae* keys out to *G. maideniana* in the *Flora of Australia* key to Goodenia (Carolin 1992). It can be differentiated from this species based on the characters stated in the key below.

Updated *Flora of Australia key* for *Goodenia*

Goodenia jabailyae can be included in the Flora of Australia key to *Goodenia* (Carolin 1992: 161) by altering couplet 26 of Group 6, as follows:

26 Main stems straight or sinuate; cauline leaves broader than linear

26a Corolla 12–15 mm long; ovules to 30; seeds 31.5–2.8 mm long, reticulate, black..... **104. G. maideniana**

26a: Corolla 9.7–10.3 mm long; ovules to 10; seeds *c.* 1.5 mm long; smooth or with faint striations, pale green to dark brown ..... **G. jabailyae**

26: Main stems zig-zag; cauline leaves linear..... **103. G. anfracta**

Scaevola goodsiorum R.W.Davis, K.A.Sheph. & L.W.Sage, *sp. nov.*

Type: south of Mount Ragged, Western Australia [precise locality withheld for conservation reasons], 7 August 2017, *M. Goods* GG 004 (*holo*: PERTH 08881162; *iso*: CANB).

Scaevola sp. Mt Ragged (M.G. Goods GG 004), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 25 June 2025].

Erect, open, sub-shrub, *c.* 30 cm high, 25 cm wide; stems terete, with a dense indumentum of appressed to ascending, fine, white hairs, 0.2–0.6 mm long, becoming glabrescent with age; axils with dense, white, long, silky hairs to 3 mm long. *Leaves* alternate, narrowly oblanceolate to elliptic, 25–65 mm long, 1.5–13 mm wide, margins entire or with scattered, shallow teeth, margin flat to shallowly recurved, both surfaces evenly covered with sparse to scattered, fine, white, hairs 0.2–0.6 mm long. *Inflorescence* condensed, axillary spikes, 7–10 mm long, 5–12 mm wide, with 3 or 4 (rarely 5) flowers. *Bracts* lanceolate, 3.3–4 mm long, 1.1–1.6 mm wide, outer surface with scattered hairs 0.4–0.5 mm long, inner surface with dense, white, silky hairs to 2 mm long, becoming glabrous towards base. *Bracteoles* narrowly lanceolate, 2.5–3 mm long, 0.5–0.7 mm wide, with white hairs to 0.5 mm long sometimes over a layer of obscure, scattered, glandular hairs < 0.1 mm long. *Sepals* free equal, rounded *c.* 0.1 mm long, glabrous, margins opaque. *Corolla* 4–5.5 mm long, white, becoming pale green towards the throat, without markings; outer surface with moderately dense hairs, 0.4–0.6 mm long, becoming glabrous towards base; inner surface with scattered, fine hairs, *c.* 0.25 mm long, becoming glabrous towards lobes, throat with three rows of stiff, course, retrorse hairs 0.2–0.3 mm long; tube almost split to the base, fused for 0.2–0.4 mm; lobes ± equal, 1.8–2.1 mm long, 0.7–1.1 mm wide, wings ± equal, 1.7–1.9 mm long, 0.1–0.3 wide. *Stamens* 5, filaments filiform, 1.3–1.7 mm long; anthers linear, 0.4–0.6 mm long. *Style* 3.4–3.6 mm long, with scattered, spreading, white hairs; indusium ovoid, 0.3–0.5 mm long, 0.6–0.9 mm wide, glabrous, lips with narrow fringe of stiff, white hairs 0.05–0.1 mm long. *Ovary* 0.7–1 mm long, with very sparse, short, simple, hairs with sessile glands. *Fruit* (immature), ellipsoid, 2.8–3 mm long, 1.1–1.3 mm wide, with very sparse short, appressed hairs; seed not seen. (Figure 2)

Diagnostic features. Distinct within the genus by virtue of the following features: narrowly oblanceolate to elliptic leaves with sparse to scattered, fine, white, hairs 0.2–0.6 mm long; inflorescence a condensed, axillary spike of 3–4(5) white flowers with a green base; sepals *c.* 0.1 mm long with an opaque margin; corolla 4–5.5 mm long, with lobes 1.8–2.1 mm long, outer surface with moderately dense hairs, 0.4–0.6 mm long, becoming glabrous towards base, inner surface with scattered, fine hairs, and three rows of stiff, course, retrorse hairs in the throat; style with scattered hairs; and indusium glabrous.*Phenology*. The specimen was in flower when collected in early August with some immature fruits also present.

Distribution and habitat. Currently known from one population of around 50 plants near Mount Ragged in the eastern Mallee bioregion of Western Australia. It is found growing in grey-brown loam over clay amongst rocks in scrubland associated with *Banksia*, *Eucalyptus* and *Stackhousia*.

Conservation status. *Scaevola goodsiorum* is currently listed as Priority Two under the Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), under the name *S.* sp. Mt Ragged (M.G. Goods 004). This species may be a disturbance opportunist, as it was apparent the plants at the type location had germinated following a recent fire (M. Goods pers. comm.).

Etymology. This species is named in honour of Maree and Graham Goods, in recognition of their substantial contribution to plant conservation through collecting specimens and photographing plants in the field. To date they have together and independently collected more than 660 voucher specimens while participating in Desert Discovery field trips in Western Australia.

Figure 2. *Scaevola goodsiorum*. A – flowering plant *in situ* growing amongst exposed rocks; B – white fan-like flowers with a green throat, no markings, and retrose hairs in the throat. Images by M. Goods (*M.G. Goods* 004).

Notes. In the spring of 2017 Australian Plants Society (Victoria) members Maree and Graham Goods travelled across the Nullarbor with the intent to collect and photograph species of the family Goodeniaceae in southern Western Australia. The fan-flower family was to be the focus for the Society's FJC Rogers

2018 Seminar and these passionate citizen scientists planned to present delegates with a virtual plant guide highlighting the extraordinary floral diversity in this captivating family. On a random stop to explore a recently burnt area south of Mount Ragged in the Cape Arid National Park, Maree found a small white flowered species of *Scaevola* growing amongst some rocks. She took the opportunity to photograph (Figure 1) and voucher the plants. When this material was subsequently lodged with the Western Australian Herbarium (PERTH) it became evident that she had in fact discovered a new species.

Affinities. *Scaevola goodsiorum* is morphologically most similar to *S. paludosa* R.Br., *S. spicigera* Carolin, *S. canescens* Benth., and the South Australian *S. linearis* R.Br. but is readily differentiated from all of these species by its sepals being *c.* 0.1 mm long (*c.f.* sepals to *c.* 0.3 mm long).

Scaevola goodsiorum is most similar to *S. canescens* Benth., but can be readily distinguished from it by the presence of dense, white, long, silky hairs in the leaf axils (vs softly felted axillary hairs that aren't dense), smaller corollas 4–5.5 mm long (vs 9–11 mm long) that lack brownish veins or markings (vs corollas with brownish veins), and being located approximately 700 km east of the known distribution of *S. canescens*.

In the *Flora of Australia* key to *Scaevola* (Carolin 1992), *S. goodsiorum* keys out to *S. paludosa*. Besides having shorter sepals, *S. goodsiorum* differs from *S. paludosa* in having narrowly oblanceolate to elliptic leaves with sparse to scattered, fine, white, hairs 0.2–0.6 mm long (vs elliptic leaves with scattered, coarse, antrorse hairs sometimes with a slightly swollen base); corolla white with a green throat and no markings and 4–5.5 mm long (vs corolla white with dark reddish brown markings and 7–10 mm long).

Updated *Flora of Australia* Key

The following is a modification to the *Scaevola* key in *Flora of Australia* (Carolin 1992) Group 4 amendment to couplet 23 (p. 91):

6: Ovary and fruit hairy

22. Flowers in lateral spikes mostly shorter than leaves

23. Sepals free; leaves ± hispid, hairs both simple and minute glandular

23a. Sepals free to *c.* 0.3 mm long; corolla 7–10 mm long; bracts shorter than bracteoles ..... **S. paludosa**

23a: Sepals free to *c.* 0.1 mm long; corolla 4–5.5 mm long; bracts longer than bracteoles ..... **S. goodsiorum**

23: Sepals reduced to a rim; leaves tomentose with dense, simple or felted hairs

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Rachel Jabaily (Colorado College) is sincerely thanked for undertaking molecular sequencing of *Goodenia pinnatifida* and allied species including *Goodenia jabailyae*, while the Goodeniaceae Study Group of Australian Plants Society are also acknowledged for providing funding towards this project. Maree and Graham Goods are also acknowledged for their significant contribution to plant conservation in Western Australia, and specifically for their large collection of Goodeniaceae species (including the holotype of *Scaevola goodsiorum*), which has assisted with ongoing taxonomic work in the family, while Neville Walsh is also thanked for providing a helpful review.

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Three new species separated from the eastern Australian *Haemodorum planifolium* (Haemodoraceae)

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Abstract

Macfarlane, T.D. & Barrett, R.L. Three new species separated from the eastern Australian *Haemodorum planifolium* (Haemodoraceae). *Nuytsia* 36: 123–139 (2025). The taxonomy of the eastern Australian species *Haemodorum planifolium* R.Br. is reviewed and it is divided into four species, three of them new. *Haemodorum brevistylum* T.Macfarlane & R.L.Barrett occurs mainly in the South Coast and Southern Tablelands regions, north to the Central Coast and Central Tablelands of New South Wales. *Haemodorum collevatum* T.Macfarlane & R.L.Barrett has a limited distribution in the Northern and Central Coast regions from Sydney to Newcastle. *Haemodorum celsum* R.L.Barrett & T.Macfarlane is a species of the Northern Tablelands region of New South Wales and the Granite Belt in the southern Darling Downs District of Queensland. *Haemodorum planifolium* R.Br. is re-described and lectotypified. In the revised sense, *H. planifolium* occurs in the Central Coast and Central Tablelands regions of New South Wales (i.e. Wollongong to Gosford, inland to Newnes). All species are illustrated and mapped and a key to the *Haemodorum* species of New South Wales is provided.

Introduction

Haemodorum Sm. (Haemodoraceae) is a genus currently of 30 species (Council of Heads of Australasian Herbaria 2006–), all occurring in Australia with one species extending to New Guinea. The most recent additions to the genus were by Barrett *et al.* (2015), who added seven species from north-western Australia. A checklist with new taxa is being published simultaneously with this paper (Hopper *et al.* 2025). In a Flora account, Macfarlane (1987, 2020) reported that *H. planifolium* R.Br., occurring in New South Wales and southern Queensland, is variable in inflorescence form and relative dimensions of some floral parts and that it required further study. We have made a more detailed study of *H. planifolium*, concluding that the current concept of that species encompasses four species, three of them newly described here. The treatment by Harden (1993) simply followed Macfarlane (1987), without mention of any morphological variants. Full descriptions and photographs of the four species are provided here.

Methods

All relevant specimens at AD, BM, BRI, L, K, MEL, NSW, PERTH and SYD were examined, along with selected specimens on loan from CANB. A digital image of a specimen at CGE was also seen (S.A. James *pers. comm.*). Type specimens have been examined at BM, MEL, NSW and online through *Global Plants* (https://plants.jstor.org/). All specimens cited have been examined unless indicated with *n.v*. *Haemodorum brevistylum* T.Macfarlane & R.L.Barrett, *H. collevatum* T.Macfarlane & R.L.Barrett

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and *H. planifolium* R.Br. have been examined in the field by RLB. We also assessed all records of *Haemodorum* from New South Wales and adjacent south-east Queensland on the citizen science platform iNaturalist (https://www.inaturalist.org/; accessed 14 February 2025). The maps are based on cited and selected other specimens and the cited iNaturalist observations.

Character notes

Most characters are depicted in the Figures and referenced in the captions.

Basal leaves are attached below ground and form a tuft at the base of the inflorescence scape. There are a varying number of leaves attached above ground (*leaves on scape*) that resemble the basal leaves in length, transitioning upwards into shorter *bracts*, the lower of which may be green and the colour may change to blackish in upper ones.

Pedicels are measured from the flower base (base of the receptacle) to the branch point below and bear two separated bracteoles, the lower and upper. Flowers terminating a main axis often have an atypical arrangement, e.g. an unusually long 'pedicel' and deviate from having two bracteoles, so they have been ignored for pedicel measuring.

Flower groupings in the inflorescence have been usually termed *aggregations* for the large, dense collection of flowers in all species other than *H. collevatum*, rather than terms such as clusters or cymes that imply a lower level of grouping.

Major branches are primary branches that bear an aggregation of flowers like (but often smaller than) the main terminal aggregation. Occasionally there is ambiguity between a terminal cluster and a major branch because of close spacing of the structures.

Terminal aggregations of flowers are those borne on the morphological terminus of the main axis, which can be identified by tracing the main axis past each branch point, the branch identifiable by its subtending bract.

A comparison of characters for the four species described here is provided in Table 1.

Table 1. Comparison of characters for species in the *Haemodorum planifolium* complex.

Character	***H. brevistylum***	***H. celsum***	***H. collevatum***	***H. planifolium***
Basal leaf number (per scape)	3–5	3–7	4–6	4–8
Leaf width	2.8–4.5(–5.5) mm	1.6–3.7(–5.7) mm	1.5–6(–7) mm	3.5–4.4 mm
Leaves and bracts on scape	Scape leaves 1 or 2, green, transitioning to blackish bracts, lowest bract to 210 mm long	Scape leaves (3)4(5), green, transitioning to blackish bracts, lowest bract to 250 mm long	Scape leaves 3 or 4, green, transitioning to glaucous-green bracts, lowest bract to 210 mm long	Scape leaves reduced, sometimes 1–3 leaf-like and green, transitioning to brownish or blackish bracts, lowest bract to 180 mm long
Scape colour	glaucous-green	brownish	glaucous-green	glaucous-green to blackish

Character	*H. brevistylum*	*H. celsum*	*H. collevatum*	*H. planifolium*
Inflorescence major branch number	0–3	1–4	4–6	1–4
Inflorescence major branch length	40–114 mm	60–90 mm	70–450 mm	20–160 mm
Inflorescence major branch angle from main axis	15–45°	10–40°	45–90°	30–55°
Inflorescence secondary branching of major branches (excl. within flower aggregations)	0–1 branched	0–1 branched	Repeatedly branched	0–1 branched
Flower grouping pattern	A dense flower aggregation terminating main axis and major branches	A dense flower aggregation terminating main axis and major branches	Small flower clusters terminating branches	A dense flower aggregation terminating main axis and major branches
Terminal flower aggregation position relative to other aggregations	Shorter	Shorter	Slightly longer, equal or slightly shorter	Shorter
Number of flowers in terminal aggregation	10–22	13–21	*c.* 6	9–30
Number of flowers in other aggregations	5–11	7–14	2–4	5–19
Pedicel length	4–10 mm	4–10 mm	6–12 mm	4–11 mm
Bracteole length	4–10 mm	10–14 mm	3.5–8 mm (lower); 4.5–7 (upper)	6.5–8.5 mm
Upper bracteole distance below flower	2–3 mm	4–8 mm	1.9–3.5 mm	1–2 mm
Flower length	9.5–11(–12.5) mm	(13–)15–19 mm	(10–)11–14 mm	(8–)9–16 mm
Anther length	2–3.2 mm	3.8–5.1 mm	3.2–3.7 mm	3.4–4.0 mm
Style length	5.8–7.5 mm	14–16 mm	(8.5–)10–12 mm	(9.5–)11.2–14.0 mm
Stigma (style apex) form	shortly trifid	entire	entire	entire
Style apex position relative to petal tips	Shorter by 2–3.4 mm	Longer by (0–) 0.5–1 mm	Longer by 0.3–1.8 mm	Longer by 0–1.2 mm
Fruit colour	bright to dark reddish brown to dark brown	greenish to brownish black	mid-brown, sometimes with a reddish tint	dark brown to blackish
Fruit diameter	7.5–8.5 mm	8–11 mm	9–14 mm	10–13 mm

Taxonomy

Haemodorum brevistylum T.Macfarlane & R.L.Barrett, *sp. nov.*

Type: SE-most walking track entrance to Tura Flora Reserve, inside High Crescent, Tura Beach, *c.* 3 km direct N of Merimbula, South Coast, New South Wales, Australia, 25 November 2024, *J. Miles* 25-17 (*holo*: NSW 1326955; *iso*: PERTH).

Plant 53–75 cm tall. *Bulb* 4–13 cm below the soil surface, red. *Basal leaves* 3–5 (up to 8 when two inflorescences present); lamina linear, flat, up to (180–)250–470 mm long, 2.8–4.5(–5.5) mm wide. *Leaves on scape* 1 or 2, green, transitioning to blackish bracts, lowest bract to 210 mm long. *Inflorescence* usually one (occasionally 2) per plant, paniculate; scape 350–690 mm long, glaucous-green; flowering portion 80–235 mm long from lowest major branch, with 0–3 major branches 40–114 mm long, the branches narrowly spreading at 15–45° from the main axis, secondary branches (excluding within flower aggregations) 0–1; flowers arranged in dense cymose aggregations, terminal on the main axis and each major and secondary branch (when present), flowers 10–22 in terminal aggregation, 5–11 in branch aggregations; terminal aggregation exceeded by those on the branches. *Pedicels* 4–10 mm long. *Bracteoles* 2, similar, 4–10 mm long, ovate to narrowly ovate, acute to acuminate, opaque, the texture fairly thick, without a differentiated broad membranous margin, veins several, obscure; upper bracteole attached 2–3 mm below the flower base, apex at *c.* 1/4 of the flower length. *Flowers* 9.5–11(–12.5) mm long; sepals similar to petals but shorter to almost equal, oblong or ovate-oblong, becoming narrowly linear when dried except for the broader unexpanded base, dark brown to black; petals 9–10(–11.5 mm long, orange-brown in lower part, dark brown to blackish in upper part. *Stamens* equal, enclosed in perianth; filaments 5.5–6.5 mm long, at least sometimes pink; anthers versatile, 2–3.2 mm long, yellow, the tip 1–3 mm below petal apex. *Style* 5.8–7.5 mm long, red to orange in upper part, yellow in lower 1/3 at anthesis, shorter than the petals by 2–3.4 mm; stigma shortly trifid, minutely papillose, positioned from the middle or to the tip of the anthers. *Fruits* bright to dark reddish brown to dark brown, glossy, 7.5–8.5 mm diameter. *Seeds* not seen. (Figure 1)

Diagnostic features. *Haemodorum brevistylum* may be distinguished from all other members of the genus by the following combination of characters: leaves flat; inflorescence paniculate, with major branches spreading at relatively narrow angles (15–45°), flowers in dense aggregations of 5–22; bracteoles at least partly dark brownish to black, without a differentiated broad membranous margin, upper bracteoles attached relatively distant from the flower base by 4–8 mm; sepals dark brown to blackish; anthers 2–3.2 mm long, held within the flower and shorter than the petal tips by 1–3 mm; style short (5.8–7.5 mm long), not exceeding anther tips and shorter than petal apices by 1–3 mm; stigma shortly trifid.

Other specimens examined. NEW SOUTH WALES: Clyde District, Nov. 1884, *W. Baeuerlen* 178 (MEL 609496); Braidwood District, Feb. 1885, *W. Baeuerlen* 437 (MEL 609539); near Hume Hwy, 1 mile N of Paddy's River Bridge, 22 Jan. 1968, *I. Beeton s.n.* (CANB CBG 022273); Agnes Banks, near Richmond, 40 m, 11 Sep. 1975, *D.H. Benson* 1320 (NSW 408425); Currockbilly Mountain near Braidwood, Mar. 1909, *J.L. Boorman s.n.* (NSW 149755); South Coast Study Area, 35°30'S, 150°10'E, 31 Mar. 1974, *L.A. Craven* 2644 (CANB); Lapstone Hill, within railway fence, 27 Oct. 1927, *O.D. Evans* 2389 (CANB 2257; SYD); St Marys, Dec. 1925, *O.D. Evans s.n.* (SYD); Spence Road between Government Road and Judd Street, Shane Park, Crown Land, 30 m, 16 Jan. 1991, *P.D. Hind 6312* (NSW 237172); near Carrington Falls, Moss Vale – Robertson area, 29 Dec. 1974, *K.H.L. Key s.n.* (CANB 249364); Lower Boro, c. 28 km N of Braidwood, 19 Jan. 1989, *P.G. Kodela & D.A. Foster s.n.* (NSW 436949); Charleyong – Tarago Rd, 15 Oct. 1952, *C.W.E. Moore* 1906 (CANB 51037); close to entrance at Rickards Road, Agnes Banks Nature Reserve, 26 m, 12 Jan. 2004, *L. von Richter 358 & W. Robertson* (NSW 615730); Yalwal, Nov. 1923, *F.A. Rodway s.n.* (NSW 149741); back of Post Office, Royal Naval College, Jervis Bay, Jan. 1924, *F.A. Rodway s.n.* (NSW 149740); Burrier Road, *c.* 8 mi [12.9 km] from Nowra, 21 Dec. 1930, *F.A. Rodway s.n.* (K *n.v.*; NSW 149739); between Stony Creek and Steamer Beach, S of Jervis Bay, 8 Feb. 1942, *F.A. Rodway s.n.* (NSW 254952); S of Jervis Bay, 8 Feb. 1942, *F.A. Rodway s.n.* (NSW 149738); Candelo [?region], Feb. 1885, *T. White s.n.* (MEL 609540).

Figure 1. *Haemodorum brevistylum*. A – base of plant showing the flat leaves and glaucous inflorescence axis [scape]; B – fruiting inflorescence showing the panicle structure, with a dense terminal aggregation of flowers and major branches with relatively narrow branch angle and a dense flower aggregation on each, exceeding the terminal one in height; C – an aggregation of post-anthesis flowers showing perianth exterior colours; D – two aggregations of late post-anthesis flowers showing developing fruits and the positions of petal tips, anthers and style tips; E – a flower aggregation from above showing flowers at anthesis (top left) with petals closed, as usual in *Haemodorum*, shorter sepals and older flowers showing red well-developed immature fruits and perianth internal colours; F – a flower aggregation with dark brown to black mature fruits. Photographs (A, C) by Max Campbell, Tura Beach, iNaturalist: 252568540 (CC-BY); (B, D, F) by Russell Barrett, Carrington Falls; (E) by Robyn Russell, Morton National Park, iNaturalist: 147053480 (CC-BY-NC).

Selected iNaturalist observations [13 of 40] (https://www.inaturalist.org/observations/). NEW SOUTH WALES: 68476885; 143628071; 146265236; 146755376; 187762828; 249839236; 250998376; 252258072; 253342237; 254364466; 254453074; 257214207; 257895959.

Phenology. Flowering from November to December (occasionally to January). Fruiting December to February.

Distribution and habitat. South Coast and Southern Tablelands regions with outlying occurrences near Sydney, Central Coast region, and Blue Mountains, Central Tablelands, New South Wales, Australia (Figure 2). The known range is from Eden north to Carrington Falls near Mossvale with outlying collections from Lapstone Hill and Agnes Banks in north-western Sydney and iNaturalist observations from the Blue Mountains. Previously it was known only as far south as the Batemans Bay area but in recent years the range has been extended 150 km southward through images posted on iNaturalist Australia (under *H. planifolium*), now supported by specimen evidence via assistance from iNaturalist contributors (e.g. *J. Miles* 25-17). The species grows in infertile soils, usually sand over sandstone, occasionally noted as sand over clay soil, in forest dominated by *Angophora bakeri*, *Corymbia* spp. (e.g. *C. gummifera*), *Eucalyptus* spp. (e.g. *E. sclerophylla, E. sieberi, E. globoidea*) and *Themeda triandra*, and also in low heathland at higher altitudes. It ranges from near sea level to higher altitudes inland. There is some evidence of it flowering following fire or other disturbance.

Conservation status. While poorly known, and with relatively few recent collections, the distribution of the species, combined with recent citizen science records, suggest that this species is not currently of conservation concern.

Etymology. The epithet is from *brevi-* (short, in Latin compounds) and *stylus* (style), in reference to the comparatively short style of this species.

Haemodorum celsum R.L.Barrett & T.Macfarlane, *sp. nov.*

Type: Basket Swamp National Park, NNE of Tenterfield, New South Wales, 9 December 2003, *A.R. Bean* 21326 (*holo*: NSW 843744; *iso*: BRI AQ764379, *n.v.*).

Illustration. G. Holmes *et al.*, *Flora of the granite belt* 117, pl. (2018) (as *H. planifolium*).

Plant 90–120 cm tall. *Bulb* 5–15 cm below the soil surface, red. *Basal leaves* 3–7 (up to 18 when more than one inflorescence present); lamina linear, flat, (120–)180–390 mm long, 1.6–3.7(–5.7) mm wide. *Leaves on scape* (3)4(5), green, lowest bract to 250 mm long, reducing in size above and transitioning to blackish bracts within the flowering portion. *Inflorescence* 1–3 per plant, paniculate; scape 890–1180 mm long, brownish; flowering portion 90–180 mm long from lowest major branch, with 1–4 major branches 60–90 mm long, the branches narrowly spreading at 10–40° from main axis; secondary branches (excluding within flower aggregations) 0–1, with flowers arranged in dense cymose aggregations, terminal on the main axis and each major and secondary branch (when present), flowers 13–21 in terminal aggregation, 7–14 in branch aggregations; terminal aggregation exceeded by those on the branches. *Pedicels* 4–10 mm long. *Bracteoles* 2, similar, 10–14 mm long, narrowly lanceolate to linear, acute to acuminate, opaque, the texture fairly thick, without a differentiated broad membranous margin, veins usually 5, obscure to slightly raised; upper bracteole attached 4–8 mm below the flower base, apex at *c.* 1/2 of the flower length. *Flowers* (13–)15–19 mm long; sepals similar to petals, subequal or 0.5–2 mm shorter, lanceolate, becoming narrowly linear when dried except for the broader unexpanded base which is 1.6–2.1 mm wide, mostly dark brownish but green at least on the expanded, somewhat saccate base; petals 12–17 mm long, orange-brown in lower part, dark brown to blackish in upper part. *Stamens* equal, enclosed in perianth; filaments 5.2–8.0 mm long; dull pink to orange-brown; anthers versatile, 3.8–5.1 mm long, yellow, the tip 3.6–5.0 mm below petal apex. *Style* 14–16 mm long, pink or red to orange or yellow in upper part, yellow to green in lower 1/2 at anthesis, usually longer than the petals by (0–)0.5–1 mm; stigma entire, slightly

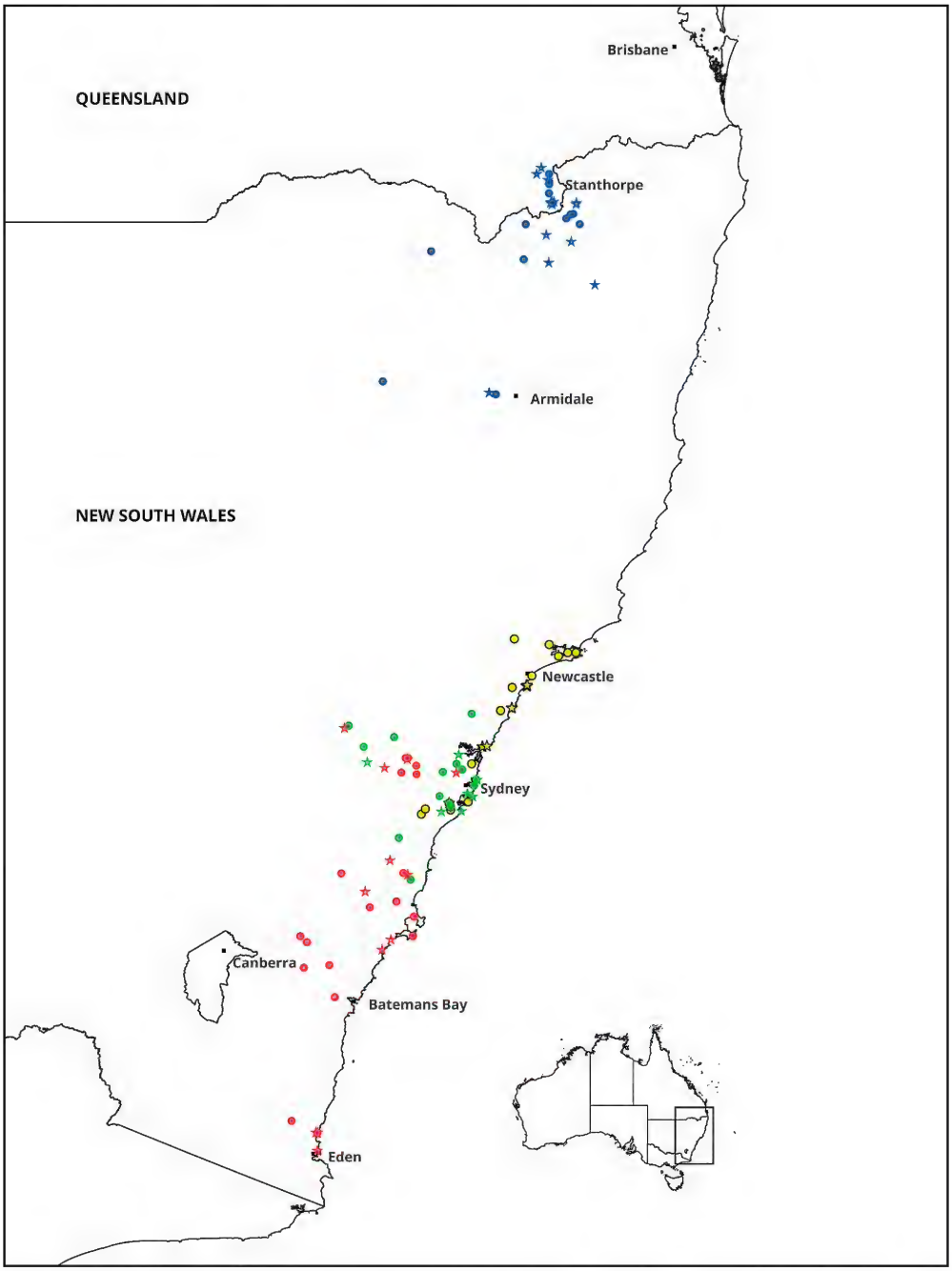

Figure 2. Distribution map for *Haemodorum* species. Symbols indicate specimen records (circles) and iNaturalist observations (stars). Species colour representations: red *H. brevistylum*, blue *H. celsum*, yellow *H. collevatum*, green *H. planifolium*.

capitate, minutely papillose, positioned 3–5 mm above the tip of the anthers. *Fruits* greenish to brownish black, glossy, 8–11 mm diameter. *Seeds* not seen. (Figure 3)

Diagnostic features. *Haemodorum celsum* can be distinguished from the other species in the genus by the combination of flat leaves; inflorescence paniculate, with major branches spreading at relatively narrow angles (10–40°), flowers in dense aggregations of 7–21; bracteoles without a differentiated broad membranous margin; flowers at least partly dark brown to blackish; sepals green, at least towards the base on the abaxial surface; anthers 3.8–5.1 mm long, held within the flower and shorter than the petal tips by 3.6–5 mm; style long (14–16 mm long), equalling or exceeding the petal tips by (0–)0.5–1 mm; stigma entire.

Selected specimens examined. QUEENSLAND: Stanthorpe, *s.dat., F.M. Bailey s.n.* (BRI AQ136742); Wyberba, 19 Jan. 1933, *S.T. Blake* 4558 (BRI AQ136740); near Ballandean, Nov. 1944, *M.S. Clemens s.n.* (BRI AQ0136741); Stanthorpe, 29 Mar. 1960, *W.T. Jones* 1427 (CANB 129706); Stanthorpe, 11 Aug. 1966, *W.T. Jones* 3227 (CANB 189736); eastern Darling Downs, *s.dat., H. Lau s.n.* (MEL 532830); Stanthorpe, Dec. 1883, *B. Scortechini s.n.* (NSW 149776). NEW SOUTH WALES: Wallangra, Nov. 1912, *J.L. Boorman s.n.* (NSW 149756); 'Dunbarra', W of Invergowrie, SE of The Pinnacle, *c.* 100 m NW of Teatree Creek, 25 Dec. 2024, *J.J. Bruhl & J.T. Hunter* JJB 3875 (NE 116203, NSW, PERTH); Torrington, 29 July 1907, *R.H.C. [Camfield?] s.n.* (SYD); Boonoo Boonoo National Park rangers house, off Mount Lindesay Road, Tenterfield, 9 Nov. 1998, *S.D. Hopper* 8403 (PERTH 09277234); Great Dividing Range, 8 miles N of Tenterfield on Mt Lindesay Highway, 24 Nov. 1973, *A.N. Rodd* 2494 (NSW 811725); granite ranges E of Barraba, Nov. 1913, [H.M.R.] *Rupp s.n.* (MEL 103494); Clifton, *s.dat., C. Stuart s.n.* (MEL 609487); New England, *s.dat., C. Stuart s.n.* (MEL 609497); Timbarra, Dec., *C. Stuart* 141 (MEL 609486, MEL 609482); Torrington, *c.* 3750 ft, 22 Feb. 1961, *J.W. Vickery s.n.* (NSW 149748).

Selected iNaturalist observations [17 of 46] (https://www.inaturalist.org/observations/). QUEENSLAND: 58581260; 107100980; 222830143; 147849742; 178341590; 248416403; 248563392; 252680099; 252773548; 254464256. NEW SOUTH WALES: 129130898; 144199020; 243740580; 246717320; 253392218; 259823125; 259824277.

Phenology. Flowering from November to December (January). Fruiting from December to February.

Distribution and habitat. *Haemodorum celsum* grows on the Northern Tablelands of New South Wales and adjacent south-east Queensland, between Stanthorpe and Walcha (Figure 2). Grows in open woodland with *Eucalyptus cameronii*, *E. campanulata*, *E. radiata*, and shrubby understorey over porphyry geology in coarse sands.

Conservation status. While relatively localised in distribution, the species is represented in a sufficient number of conservation reserves that it is not currently considered to be of conservation concern.

Etymology. The epithet is from the Latin *celsus* (prominent, elevated), in reference to the location of this species on the New England Tableland, at higher elevations than its relatives *H. brevistylum* and *H. planifolium*. It also refers to the long style, with the apex commonly exposed above the tepals at anthesis.

Notes. A mixed collection of *H. collevatum* and *H. celsum* by the early collector, scientist and explorer Ludwig Leichhardt in about 1842, 'going to Mr Hurry's, New England' (MEL 609494) suggests that he distinguished the two species during his journey although the combining of the material indicates that this distinction was not appreciated until now. Mr Hurry appears to be Edward Hurry who had established the pastoral property Bolivia in 1840 or 1841 and sold it in 1842 (Irby 1939), now the locality Bolivia in Shire of Tenterfield, Northern Tablelands region, New South Wales.

Figure 3. *Haemodorum celsum*. A – a plant with two inflorescences showing major branches with relatively narrow branch angles and flowers in dense aggregations on terminus and major branches; B – flower (centre) at anthesis with closed perianth with brown sepals and petals green at the base, stigma just showing above petal tips and bracteoles distinctly separated from the flower base; C – the same flower with a petal and a sepal removed, showing a stamen well-enclosed within the flower (style not shown); D – a flower (right) with a dull reddish full size immature fruit and style as long as the persistent perianth. Photographs by Jeremy Bruhl, W of Invergowrie (Voucher: *J.J. Bruhl & J.T. Hunter* JJB 3875, NE).

Haemodorum collevatum T.Macfarlane & R.L.Barrett, *sp. nov.*

Type: Nelson Bay [Port Stephens, New South Wales], 2 December 1964, *G.M. Lithgow s.n.* (*holo*: NSW 149742).

Plant 65–135 cm tall. *Bulb* to 25 mm diameter, 6–21 cm below the soil surface, dark orange. *Basal leaves* 4–6; lamina linear, flat, 350–1060 mm long, 1.5–6(–7) mm wide. *Leaves on scape* 3 or 4(5), green, transitioning to glaucous-green bracts, lowest bract to 210 mm long. *Inflorescence* one (rarely 2) per plant, paniculate; scape 620–1310 mm long, glaucous-green; flowering portion from lowest major branch 150–450 mm long, with 4–6 primary branches 70–450 mm long, the branches widely spreading at 45–90° from main axis, secondary branching well developed, sometimes repeatedly; flowers in small dense cymose aggregations terminal on the main axis and major and secondary branches, 4–6(–8) in terminal aggregation, 2–4 in branch aggregations; terminal aggregation slightly exceeding, equalling or slightly shorter than those on the branches. *Pedicels* 6–12 mm long. *Bracteoles* 2, similar or the lower broader, the texture fairly thick, opaque, without a differentiated broad membranous margin, veins several, obscure; lower bracteole 3.5–8 mm long, narrowly ovate, ovate or obovate, acute; upper bracteole 4.5–7 mm long, ovate to narrowly oblong, acute to obtuse, attached 1.9–3.5 mm below the flower base, the apex at base or to *c.* 1/4(–1/2) of the flower length. *Flowers* (10–)11–14 mm long; sepals similar to petals but 1–1.5 mm shorter, narrowly oblong to almost lanceolate, dark brownish, to dark greenish brown towards base; petals 10–13 mm long, dark brownish, sometimes with a purple tint. *Stamens* equal, enclosed in perianth; filaments 6–7 mm long, yellowish; anthers versatile, 3.2–3.7 mm long, yellow, the tip 2.3–4.1 mm below petal apex. *Style* (8.5–)10–12 mm long, orange-red at apex, pale green in lower 1/3, longer than the petals by 0.3–1.8 mm; stigma entire, slightly capitate, positioned 3–4.1 mm above the anther tips, exceeding petal tips by 0.3–1.8 mm. *Fruits* mid-brown, sometimes with a reddish tint, glossy, 9–14 mm diameter. *Seeds* black, winged-discoid, 6–7 mm long, 4–5 mm wide. (Figures 4, 5)

Diagnostic features. *Haemodorum collevatum* is distinguished from all other species in the genus by the leaves flat; inflorescence an open panicle with major branches spreading at wide angles (45–90°), usually repeatedly branched with flowers in small clusters of 2–4 (*c.* 6 in terminal cluster); flowers at least partly dark brownish; bracteoles without a differentiated broad membranous margin; anthers 3.2–3.7 mm long, held within the flower and shorter than the petal tips by 2.3–4.1 mm; style exceeding petal tips by 0.3–1.8 mm; stigma entire.

Other specimens examined. NEW SOUTH WALES: 50 m N of Coolgardie Crescent, Burnum Burnum Nature Reserve, Sutherland, 20 Feb. 2025, *R.L. Barrett* RLB 9676 (CANB, MEL, NSW, PERTH); Charmhaven, NE of Wyong, 15 Nov. 1969, *B.G. Briggs* 2988 (NSW 254895); Kings town, Newcastle, Nov. 1804, *R. Brown s.n.* [Iter Austral. 5619] (BM (BM000552334)); Hunters River, *R. Brown s.n.* (E (E00682543) image!); Kingstown, Hunters River, *s.dat.*, *R. Brown s.n.* (K (K000846224; K000846230); Newcastle, *s.dat.*, *R. Brown s.n.* [Iter Austral. 5619] (K (K000846222)); Port Stephens, *s. dat.*, *Burnett* (CGE 00063182, image!); Newcastle, 19 Nov. 1901, *R.H. Cambage* 604 (NSW 254961); [Royal] National Park, Dec. 1895, *J.H. Camfield s.n.* (NSW 149732); Toronto, Oct. 1924, *E. Cheel s.n.* (NSW 149746); Salamander Bay, Port Stephens, 20 ft, *s. dat.*, *S. Clarke s.n.* (NSW 149747); Temptation Creek, Royal National Park, 30 Apr. 1984, *R. Coveny* 11839 & *W. Bishop* (NSW 630463, PERTH 01735152); Bahai Temple, Ingleside, 24 Nov. 1981, *R. Coveny* 11070 & *P. Hind* (NSW 628971; K, L, MO, RSA all *n.v.*); Botany Bay National Park, Kurnell, Polo Road, 15 m, 23 Apr. 2007, *D.M. Crayn*, *R.G. Coveny* & *M.R. Whitehead* 1084 (NSW 759563); 2 mi. [3.2 km] W of Karuah, 12 Oct. 1953, *L.A.S. Johnson s.n.* (NSW 149743); 600 m W of Georges River crossing on Wedderburn Road, Georges River Nature Reserve, 260 m, 3 Apr. 1992, *M. Kennedy* 322 & *P. Hind* (NSW 253303); Georges River, Kentlyn, 19 Nov. 1966, *E.J. McBarron* 13594 (NSW 254968); Georges River, Kentlyn, 21 Dec. 1966, *E.J. McBarron* 13725 (NSW 2192294); Paterson, Nov. 1924, *J.D. Tucker s.n.* ex *H.M.R. Rupp* (MEL 103497); *c.* 2 km due S of Tanilba, 5 Nov. 1979, *H. Van Rees* 177 (MEL 578243).

Figure 4. *Haemodorum collevatum*. A – an inflorescence at anthesis showing the wide branching angle, small flower aggregations and glaucous inflorescence axis [scape]; B – two inflorescences with flowers at anthesis and developing fruit showing repeated branching, wide branch angles panicle structure and small flower aggregations; C – base of plant with flat leaves and two inflorescence axes; D – part of an inflorescence axis showing glaucous surface, a green leaf-like bract and flat leaf blades; E – a flower cluster showing two flowers at anthesis with perianth closed, green and partly black sepals and reddish brown petals, the long style with stigma shortly exposed above tips of petals and green and blackish bracteoles; F – full size immature dull reddish fruits. Photographs A–C, E, F, from Awabakal Nature Reserve; D from Newcastle. (A) by Tom Fletcher, iNaturalist: 251106974 (CC-BY-NC); (B, C) by Gary Williams, iNaturalist: 143981253 (CC-BY-SA); (D) by Ron O'Reilly, iNaturalist: 141947754 (CC-BY-NC-ND); (E, F) by Karen Nicoll, iNaturalist: 249565576, 143231040 (CC-BY-NC).

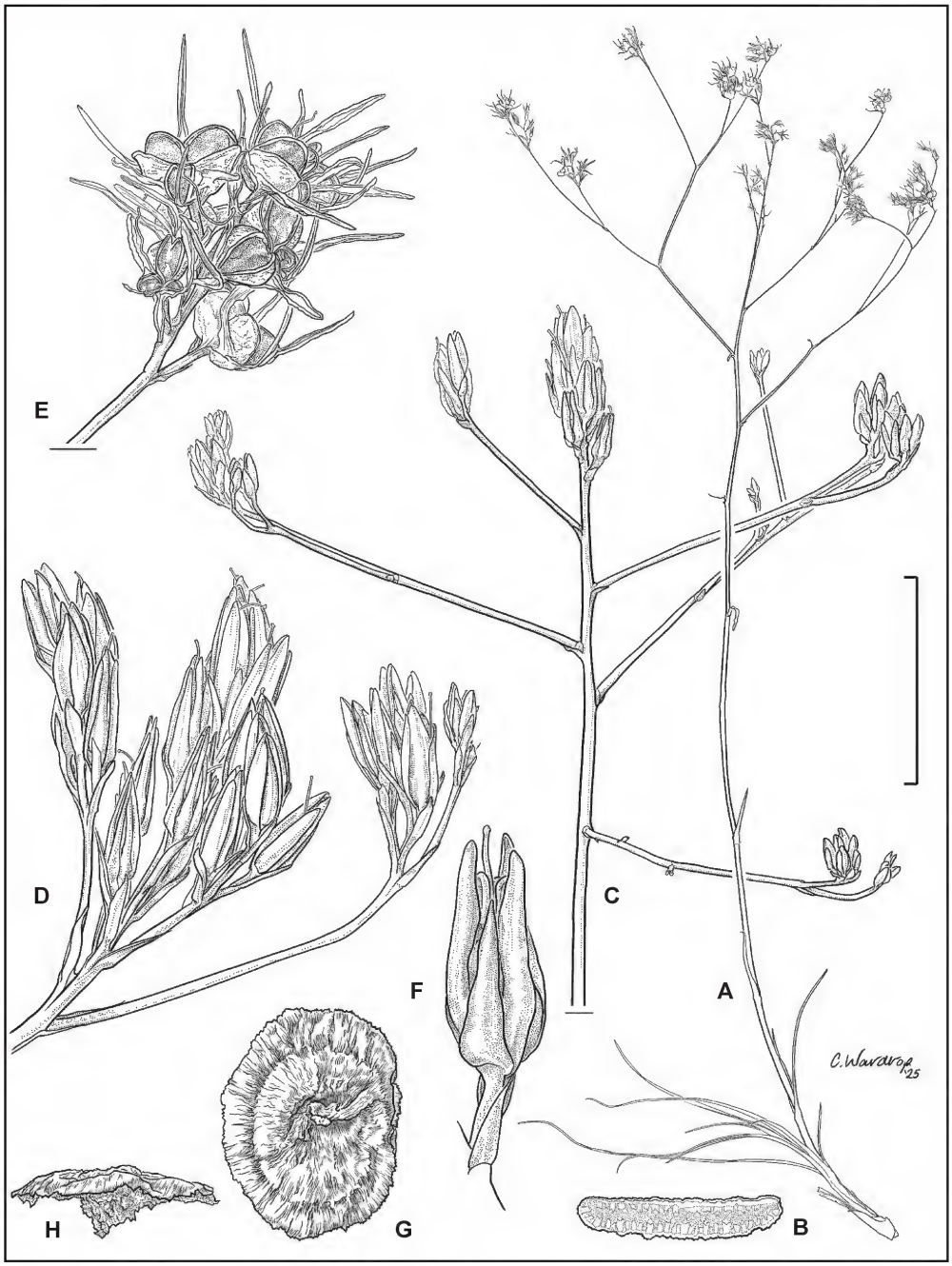

Figure 5. Illustration of *Haemodorum collevatum*. A – habit; B – leaf cross-section; C – branching habit; D – inflorescence; E – infructescence; F – spent flower, showing protruding stigma and anther position; G – seed, dorsal view; H – seed, lateral view, showing stalk. A, B, E, G, H from *R.L. Barrett* RLB 9676 (NSW); C: Drawn from a photograph by Tom Fletcher, iNaturalist: 251106974; D: Drawn from a photograph by fw_bouddi, iNaturalist: 250235806; F: Drawn from a photograph by sitsci, iNaturalist: 141947754. Scale bar: A = 26.7 cm; B = 4 mm; C = 50 mm; D, E = 25 mm; F = 13.3 mm; G, H = 5 mm. Illustration by Catherine Wardrop.

Selected iNaturalist observations [13 of 21] (https://www.inaturalist.org/observations/). NEW SOUTH WALES: 141947754; 143231040; 143929822; 143981253; 184482225; 240482672; 240484989; 249565576; 251106974; 251266985; 252789727; 258798661; 262307743.

Phenology. Flowering from November to December. Fruiting from December to January.

Distribution and habitat. Most collections of *H. collevatum* are from the Central Coast region around Newcastle, between Charmhaven and Port Stephens, with additional records from as far south as the Georges River and Royal National Park, New South Wales, Australia (Figure 2). Growing in deep coastal sand or dry sclerophyll forest, usually near the coast or tidal rivers. Recorded in association with the dominants *Angophora costata*, *A. floribunda*, *Calytrix tetragona*, *Eucalyptus pilularis*, *E. robusta*, *Leptospermum arachnoides*, *L. flavescens*, *Melaleuca nodosa* and *M. thymifolia*.

Conservation status. While relatively restricted in the northern part of its range between Charmhaven and Port Stephens, its presence in the greater Sydney region suggests that current records underestimate its distribution. Further surveys for this species are encouraged, but it is probably not currently threatened as a species, though it does face development pressures across much of its range and it should be monitored.

Etymology. The epithet is derived from a combination and contraction of the Latin *collis* (hills), and *elevatio* (to lift up, hoist), a reference to the widely spreading, sparse inflorescence that is tallest in the centre, resembling the iconic Australian 'Hills Hoist' clothesline.

Notes. *Haemodorum collevatum* differs from *H. planifolium* and *H. celsum* by the distinctive shape of the inflorescence, with widely spreading (*vs* ± erect, compact) branches bearing few-flowered (2–5(–7)-*vs* 5–11-flowered) cymose clusters. The style in this species varies from occasionally slightly shorter to usually slightly longer than the perianth, individual specimens being consistent for one or the other. These three species are also each consistent in having styles longer than the perianth and distinctly longer than the anthers, distinguishing them from *H. brevistylum*, which has styles not exceeding the apex of the anthers.

Robert Brown's collections (excluded syntypes of *H. planifolium*) were the earliest made of this species, whose status has remained unrecognised for at least 215 years, partly because it has seldom been collected over this time-span.

Some confusion has arisen between *H. collevatum* and *H. austroqueenslandicum* Domin, as some individuals with small inflorescences are difficult to interpret. An example is the specimen Hastings River, *s. dat.*, *Dr Beckler s.n.* (MEL 609491) that has an inflorescence like *H. collevatum* except that the terminal flower cluster is of three flowers (4–6(–8) recorded for *H. collevatum*), the main axis is flexuose, and the style is shorter, the stigma appearing shortly trifid and positioned 3 mm below the petal tips, like *H. austroqueenslandicum* (*vs* entire and 3–4.1 mm beyond the petals in *H. collevatum*). These unplaced specimens may represent an undescribed species and require further collecting and research. The illustration by Beadle (1987 p. 963, Fig. 421) is based on one of these unplaced plants.

Haemodorum planifolium R.Br., *Prodr. Fl. Nov. Holland* 300 (1810).

Type citation: (J.) v.v. *Type specimens*: Australia, New South Wales, between Sydney and South Head, October 1803, *R. Brown s.n.* [Iter Austral. 5619] (*lecto*: BM (BM000588667)), designated here; *possible isolecto*: Port Jackson [Sydney], *s.dat.*, *R. Brown s.n.* (BM (BM000552332), NSW 276999). *Residual syntypes* (see below under *Typification note*): heaths near Kings town, Newcastle, Nov^{r} 1804, *R. Brown s.n.* [Iter Austral. 5619] (BM (BM000552334)); Hunters River, *s.dat.*, *R. Brown s.n.* (E (E00682543 image!)); Kingstown, Hunters River, *s.dat.*, *R. Brown s.n.* (K (K000846224, K000846230)); Newcastle [no original label], *s.dat.*, *R. Brown s.n.* [Iter Austral. 5619] (K (K000846222)).

Illustrations. A. Fairley & P. Moore, *Native Pl. Sydney Distr*. 373, Plate 1367 (2002); D.J. Mabberley & D.T. Moore, *Bull. Nat. Hist. Mus., London, Bot.* 29: 190, Bauer watercolour drawing 208 (1999).

Plant 65–85 cm tall. *Bulb* 8–20 cm below the soil surface, red. *Basal leaves* 4–8; lamina linear, flat, (210–)250–440 mm long, 3.5–4.4 mm wide. *Leaves on scape* usually reduced, sometimes 1–3 leaf-like and green, transitioning to brownish or blackish bracts, lowest bract to 180 mm long. *Inflorescences* 1(–3) per plant, paniculate; scape 640–840 mm long, glaucous-green to blackish; flowering portion 100–150 mm long from lowest major branch, with 1–4 major branches 20–160 mm long, the branches narrowly spreading at 30–55° from main axis; secondary branches (excluding within flower aggregations) 0–1; flowers arranged in dense cymose aggregations, terminal on the main axis and each major and secondary branch (when present), flowers 9–30 in terminal aggregation, 5–19 in branch aggregations; terminal aggregation exceeded by those on the branches. *Pedicels* 4–11 mm long. *Bracteoles* 2, similar, 6.5–8.5 mm long, narrowly lanceolate, acute, opaque, the texture fairly thick, without a differentiated broad membranous margin, veins 5, prominent and raised when dry; upper bracteole attached 1–2 mm below the flower base, apex at 1/4–1/2 of the flower length. *Flowers* (8–)9–16 mm long; sepals similar to petals, subequal or up to 1 mm shorter than petals, lanceolate, becoming narrowly linear when dried except for the broader unexpanded base which is 1.6–2.5 mm wide, mostly dark brownish but sometimes with a purplish or greenish tint, somewhat saccate base when dried; petals (6.6–)8.7–15 mm long, dark brown but sometimes with a purplish or greenish tint. *Stamens* equal, enclosed in perianth; filaments yellowish, 4.1–7.0 mm long; anthers versatile, 3.4–4.0 mm long, yellow, the tip 2.2–4.7 mm below petal apex. *Style* (9.5–)11.2–14.0 mm long, orange in upper part, yellowish or greenish in lower 1/3 at anthesis, equal to or up to 1.2 mm longer than the petals; stigma entire but slightly capitate, minutely papillose, positioned 2.8–4.2 mm above the tip of the anthers. *Fruits* dark brown to blackish, glossy, 10–13 mm diameter. *Seeds* not seen. (Figure 6)

Diagnostic features. *Haemodorum planifolium* may be distinguished from all other species in the genus by the flat leaves; inflorescence paniculate, major branches spreading at relatively narrow angles (30–55°), flowers in dense aggregations of 5–30; bracteoles without a differentiated broad membranous margin, upper bracteole attached close to the flower base, 1–2 mm below; flowers at least partly dark brownish; anthers 3.4–4 mm long, held within the flower, 2.8–4.2 mm shorter than the petal tips; style long (10–15.7 mm), the tip approximately equalling the petal tips or exceeding them by up to 1.2 mm; stigma entire.

Selected specimens examined. NEW SOUTH WALES: Voyager Point Wetland Reserve, *c.* 100 m N of Sirius Drive on N side of oval, 20 Feb. 2025, *R.L. Barrett* RLB 9678 (NSW); Barren Grounds Faunal Reserve, 1972, *E. Conabere* 381 (NSW 254944); Nepean Dam, Bargo, 1600 ft, 1 Dec. 1953, *E.F. Constable s.n.* (NSW 26451); 5.4 km SE of Bell, 28 Mar. 1984, *R. Coveny* 11836 *& C. Miller* (K, L, MO *n.v.*, NSW 630283, PERTH 01735160); on road from Mountain Lagoon to Bilpin, 19 Apr. 1977, *P. Hind* 943 (NSW 233657); Williams Park, North Bondi, 6 May 1951, *L.A.S. Johnson s.n.* (NSW 149734); *c.* 1 mile S of Castle Hill, 5 Mar. 1966, *D.J. McGillivray* 1674 (NSW 630457); St Ives - Tumbledown Dick, 4 Dec. 1952, *C.W.E. Moore* 2157 (CANB 51038); 1.2 km NE of Asquith Railway Station, 19 Aug. 1986, *A.N. Rodd* 4665 (NSW 2192296); North Head Reserve, Port Jackson, 13 Dec. 1934, *F.A. Rodway s.n.* (K image!, NSW 149730); Manly Point, Sydney, 15 Dec. [18]86, *A. Toepffer* 191 (MEL 609537); Sunnyside Road, 2.4 km from Birds Rock Trail, Newnes State Forest, 26 Mar. 1993, *A.J. Whalen* 41, *P.D. Hind & J. Cornford* (NSW 268502); Kulnura near Gosford, 5 Dec. 1935, *C.T. White* 10244 (BRI AQ0136743).

Selected iNaturalist observations [9 of 197] (https://www.inaturalist.org/observations/). NEW SOUTH WALES: 98165561; 102457525; 105545182; 139716015; 187990759; 188452756; 250235806; 252787766; 252971538.

Phenology. Flowering from November to December. Fruiting from December to February.

Distribution and habitat. *Haemodorum planifolium* occurs from Gosford south to Wollongong, extending inland to Barren Grounds and the Newnes Plateau (Greater Blue Mountains) in New South Wales

Figure 6. *Haemodorum planifolium*. A – plant base with several leaves; B – basal leaves with flat blades and an inflorescence axis; C – an inflorescence showing its structure with a large terminal flower aggregation and two smaller aggregations on major branches (flowers mostly at anthesis); D – upper part of an inflorescence showing the terminal flower aggregation (flowers mostly post-anthesis with red developing fruits) and a major branch with a smaller flower aggregation (flowers younger, at anthesis with protruding style tips showing entire stigmas); E – a flower aggregation showing greenish brown sepals without green at base, reddish brown petals and bracteoles positioned close to flower bases (flowers either at anthesis with protruding style tips or pre-anthesis); F – old dehisced fruits. Photographs by Russell Barrett, (A, E) Royal National Park, iNaturalist: 188452756 (CC-BY-NC); (B–D, F) near Leura, Blue Mountains.

(Figure 2). Growing almost exclusively on sandstone substrates, though sometimes in coastal situations that are also limestone-rich, often in run-on zones that are seasonally wet, usually in low heath or open woodland in association with a range of *Angophora*, *Banksia*, *Corymbia* and *Eucalyptus* species.

Conservation status. Relatively common within its range and not currently considered to be of conservation concern.

Etymology. The epithet is from the Latin *planus* (flat, level), and *folia* (leaf), presumably a reference to the compressed to flat leaves in this species.

Typification note. Brown's known specimens, cited by Mabberley and Moore (2022), indicate that he collected this species from at least two areas, Newcastle and Sydney/Port Jackson and collections from those areas are regarded here as representing two collections. The lectotype is chosen in order to fix the application of the name and comes from among the sheets labelled either Sydney or Port Jackson. The lectotype sheet comprises complete plants with well-preserved flowers at anthesis and a reasonably precise locality statement. A possible duplicate is labelled Port Jackson but does not have an original label and the flowers are more mature than on the lectotype, so there is doubt about whether it is part of the same gathering. On an annotation slip in 1983, during preparation of the *Flora of Australia* account (Macfarlane 1987), TDM indicated as lectotype a specimen from Newcastle (BM000552334), although this lectotypification was not published. Mabberley and Moore (2022, p. 193) indicated that this specimen (but with barcode apparently accidentally omitted) was, in their terminology, a Good Candidate For Lectotypification. We now consider that the Newcastle collections by Brown are the taxon we are here naming *H. collevatum*, so the designated lectotype fixes the name *H. planifolium* to plants occurring around Sydney and represents the most commonly collected species in this group.

Key to *Haemodorum* species in New South Wales, Australia

1. Leaves terete to compressed, 1–2 mm wide (sometimes broader at base)

2. Flowers 12–15 mm long; flowers in several–many-flowered clusters ..... **H. corymbosum**

2: Flowers 4–5 mm long; flowers solitary or in few-flowered clusters..... **H. tenuifolium**

1: Leaves flat, usually more than 2 mm wide

3. Style distinctly shorter than the tips of the petals; stigma shortly trifid or lobed

4. Flowers solitary; inflorescence a narrow panicle; branches raceme-like ..... **H. austroqueenslandicum**

4: Flowers in clusters or large aggregations of 5–22; major branches with cymose branching ..... **H. brevistylum**

3: Style equal to or longer than the tips of the petals; stigma entire

5. Inflorescence an open, widely spreading panicle, major branches widely spreading at angles to the main axis of 45–90°, scape glaucous-green; flowers in several to numerous small aggregations of 2–4 (*c.* 6 in terminal aggregation) ..... **H. collevatum**

5: Inflorescence a dense panicle, often branched with separate dense flower aggregations, major branches at narrow angles to the main axis of 10–55°, scape glaucous-green to blackish; flowers in large aggregations of 5–11

6. Bracteoles 10–14 mm long; upper bracteole attached 4–8 mm below the flower; style 14.0–16.0 mm long ..... **H. celsum**

6: Bracteoles 6.5–8.5 mm long; upper bracteole attached 1–2 mm below the flower; style (9.5–)11.2–14.0 mm long..... **H. planifolium**

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PERTH, SYD. Steve Hopper for discussion and sharing information. Jackie Miles for her contributions to iNaturalist Australia, for enthusing other local naturalists to search for plants and for collecting the type specimen of *H. brevistylum* at our request, including detailed habitat information. Jeremy Bruhl and John Hunter kindly sought out new collections of *H. celsum* near Armidale on Christmas day, 2024. Thomas Mesaglio, iNaturalist expert, for advice and help on iNaturalist matters. Shelley James for a CGE specimen image resulting from her Churchill Fellowship project. Max Campbell, Tom Fletcher, Karen Nicoll, Ron O'Reilly, Robyn Russell and Gary Williams are thanked for permission to reproduce their images posted on iNaturalist. Catherine Wardrop is thanked for her fine illustration of *H. collevatum*.

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An annotated checklist of Haemodoraceae, including new taxa and new combinations

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Abstract

Hopper, S.D., Smith, R.J. & Hickman, E.J. An annotated checklist of Haemodoraceae, including new taxa and new combinations. *Nuytsia* 36: 141–238 (2025). In order to provide an up-to-date checklist of Haemodoraceae informed by published and forthcoming molecular phylogenetics, we describe the following new taxa and make new combinations as follows: *Haemodorum* subg. *Gemina* Hopper & R.J.Sm., *H.* subg. *Antiqua* Hopper & R.J.Sm., *H. sandifordiae* Hopper & E.J.Hickman, *H. clarksonii* Hopper & E.J.Hickman, *H. ghungalorum* Hopper, *Paradilatris* (Hopper ex J.C.Manning) Hopper, *Paradilatris viscosa* (L.f.) Hopper, *Wachendorfia laxa* W.F.Barker ex Hopper, *Conostylis* subg. *Appendicula* (Geer.) Hopper, *C.* subg. *Divaricata* (Hopper) Hopper, *C.* sect. *Terraflora* Hopper, *C. glabra* Hopper, *C. magna* Hopper, *C. bungalbin* Hopper, *C. aculeata* R.Br. subsp. *bolghinup* Hopper, *C. robusta* Diels subsp. *hickmaniae* Hopper, *C. dasys* (Hopper) Hopper, *Anigozanthos decrescens* (Hopper) Hopper & R.J.Sm., *A. condingupensis* Hopper & R.J.Sm., *A. knappiorum* Hopper, *A. yorlining* Hopper, *A. humilis* Lindl. subsp. *grandis* Hopper, *A. viridis* subsp. *sophrosyne* Hopper, and *A. viridis* Endl. subsp. *metallicus* Hopper. We also reinstate Haemodoraceae tribe Wachendorfieae, *Haemodorum subvirens* F.Muell., *H. leptostachyum* Benth. and *H. flaviflorum* W.Fitzg., and make adjustments in the circumscription of subgeneric taxa in *Conostylis* R.Br. and *Anigozanthos* Labill. Notes on variation in need of further taxonomic research are provided in the checklist. With these changes Haemodoraceae is a family of two subfamilies, four tribes, 16 genera and 132 species as follows: Haemodoraceae subfamily Haemodoroideae (10 genera/51 species) comprising tribe Haemodoreae Dumort. (4/38) and tribe Wachendorfieae Dumort. (6/13), and subfamily Conostylidoideae T.Macfarlane & Hopper (6/81) comprising tribe Conostyleae Benth. (5/69) and tribe Tribonantheae T.Macfarlane & Hopper (1/12). We do not support the recent recognition of Haemodoraceae tribe Anigozantheae Z.H.Feng.

Introduction

Haemodoraceae is a small family of 132 species of herbaceous monocots of global horticultural interest and placed in the Commelinales (APG IV 2016; Zuntini *et al.* 2021). They are distributed across Australia + Papua New Guinea, the Americas and South Africa, mainly on old climatically-buffered infertile landscapes (OCBILs – Hopper 2009, 2018, 2023; Hopper *et al.* 2016, 2021; Silveira *et al.* 2021), and have been the subject of a complicated taxonomic history until the advent of modern studies. Today, two subfamilies are recognised (Macfarlane *et al.* 1987; Hopper *et al.* 2009): the Haemodoroideae, comprising herein ten genera and 51 species distributed across the global range of the family, and the Conostylidoideae T.Macfarlane & Hopper, endemic to the Southwest Australian Floristic Region (SWAFR, *sensu* Hopper & Gioia 2004; Gioia & Hopper 2017; Figure 1) with six genera and 81 species.

Work towards the present checklist commenced with the senior author's PhD on speciation in *Anigozanthos* Labill. (Hopper 1978a) and papers therein (Hopper 1977a, 1978b, 1980; Hopper & Campbell 1977). Contributions to the treatment of Haemodoraceae in the *Flora of Australia* assembled what was then known

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about Australian members of the family, including descriptions of 17 new species in *Conostylis* R.Br. (Hopper 1987c), *Haemodorum* Sm. (Macfarlane 1987a) and *Tribonanthes* Endl. (Macfarlane 1987b) and a new subspecies in *Phlebocarya* R.Br. (Macfarlane 1987c). Simpson's (1990) PhD was the first attempt to erect a phylogeny of the family using morphological and anatomical characters, clarifying, in particular, the correct placement of *Phlebocarya* in subfamily Conostylidoideae rather than the Haemodoroideae in which it previously was placed. Specific morphological cladistic and molecular phylogenetic studies of *Anigozanthos* as then known were also published (Anderberg & Eldenaas 1991 and Le Roux *et al.* 2010 respectively). Hopper *et al.* (1999) were the first to investigate generic relationships through molecular phylogenetics research, commencing a program involving increasingly better taxon sampling thereafter (Hopper *et al.* 2009, in prep.; Zuntini *et al.* 2021).

Now that a revision of Neotropical species has been published (Pellegrini *et al.* 2020), and a revision of problematic genera such as *Tribonanthes* from the SWAFR and *Haemodorum* from the Kimberley of Western Australia is in hand (Barrett *et al.* 2015; Hickman & Hopper 2019), this paper updates the taxonomy of the family consistent with current molecular phylogenetic evidence through an annotated checklist, descriptions of new taxa, and new combinations. The paper also recognises the three new *Haemodorum* species described by Macfarlane and Barrett (2025).

Taxonomic concepts and methods

The checklist was compiled through review of historical literature. Clades are formally named if they are hypothesised to be monophyletic and usually diagnosable with apomorphies. The family Haemodoraceae itself is an exception to the latter criterion, having no apomorphies known other than from molecular sequences. Species-level molecular phylogenetic studies of *Conostylis* and *Tribonanthes* were previously published (Hopper *et al.* 2006; Hickman 2019). Similar studies on *Haemodorum* and *Anigozanthos* to inform taxonomic decisions are in preparation, although a start had been made previously in *Anigozanthos* by Le Roux *et al.* (2010). Based on that study, which only looked at three genera, Feng (2025) erected the tribe Anigozantheae with no comment. This is not supported in more comprehensive phylogenetic studies of Haemodoraceae (Hopper *et al.* 2009; Zuntini *et al.* 2021) and is not accepted here.

We have used standard herbarium and field collection approaches and molecular phylogenetics to test hypotheses as to the status of taxa. Our aim is to effect minimal change in nomenclature consistent with current scientific evidence, a fundamental principle articulated in the Preamble to the *International Code of Botanical Nomenclature* (Turland *et al.* 2018). There has been a long tradition in treatments of the Haemodoraceae of recognising monotypic taxa at generic level such as *Macropidia* J.Drumm. ex Harv., *Blancoa* Lindl., *Barberetta* Harv., *Cubanicula* Hopper, J.E.Gut., E.J.Hickman, M.Pell. & R.J.Sm. and *Lachnanthes* Elliott. While recognition of monotypic clades is often shunned (e.g. APG IV 2016; Zuntini *et al.* 2021; Feng 2025), we continue to recognise monotypic genera in Haemodoraceae to align our treatment with the principle of minimal nomenclatural change in the Preamble to the *Code*. Monotypic clades also can be justified on the basis that evolution occurs both cladistically (branching of clades through speciation) and anagenetically (divergence through time along the same evolutionary branch), and that extinction of close relatives can leave isolated and very distinct lineages that should not be merged with their nearest sister taxa. Depending on natural selection, diversification paths and rates of evolution and extinction, it is not unexpected that single species may diverge dramatically from their sister taxa and merit recognition at a higher taxonomic level to reflect this. Such recognition emphasises the differences and thereby conveys more information about the taxa concerned, which can be important in conservation.

We have conducted extensive herbarium and field studies of Haemodoraceae and base the following taxonomy on evidence gained from both dried and fresh material. Herbarium collections examined by our team, including the companion paper on Neotropical Haemodoraceae (Pellegrini *et al.* 2020), included specimens at AD, ALCB, B, BA, BHCB, BHZB, BM, BOTU, BRIT, C, CAL, CANB, CBG, CEPEC, CESJ, CGE, CGMS, CNMT, COL, COR, CORD, CVRD, EAC, ESA, F, FCAB, FCQ, FLOR, FURB, GUA, HAMAB, HAS, HB, HBR, HDCF, HRB, HRCB, HSTM, HUCS, HUEFS, HUFSJ,

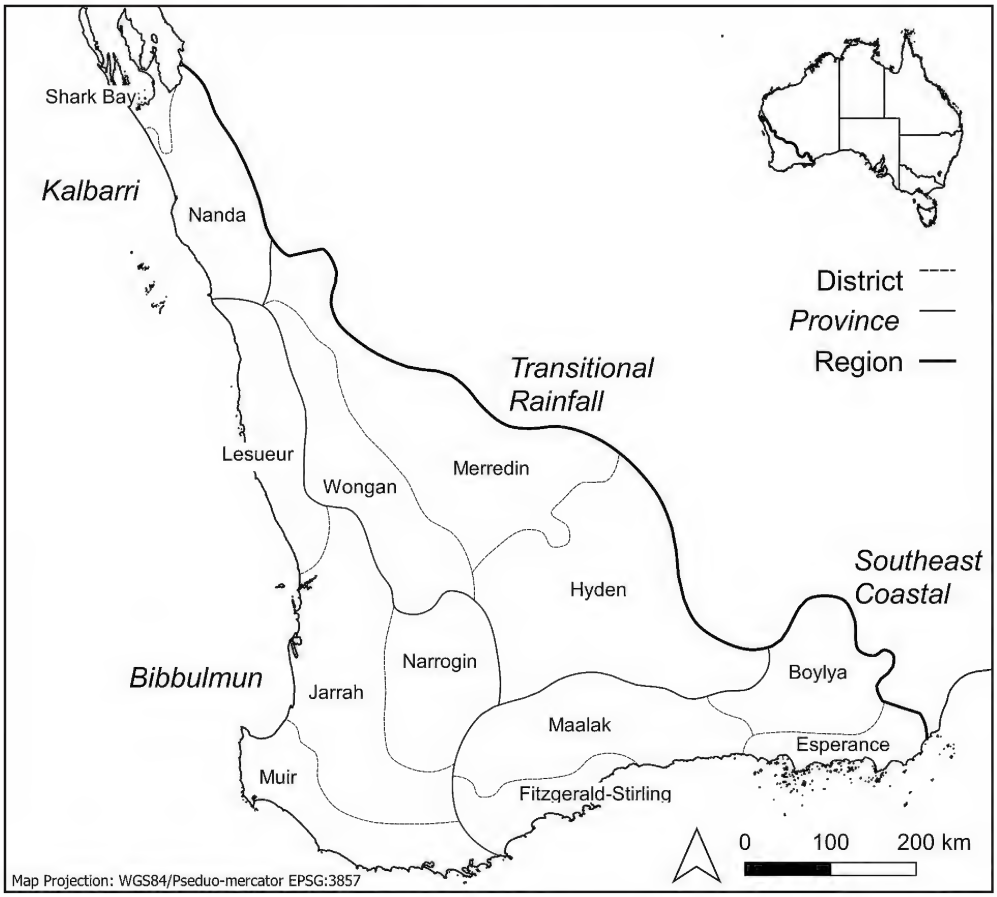

Figure 1. The Southwest Australian Floristic Region *sensu* Gioia and Hopper (2017), illustrating Provinces and Districts resulting from a multivariate analysis of locations on specimens in the Western Australian Herbarium.

HURB, IAC, ICN, INPA, JOI, K, L, MBM, MBML, MEL, MG, MO, MY, NBG, NSW, NY, P, PACA, PERTH, PMSP, R, RB, RFA, RFFP, SCP, SP, SPF, SPSF, U, UEC, UFRN, UPCB, US, USF, W, WAG, and WU. Distribution maps were compiled from herbarium specimen locations listed in the Atlas of Living Australia, the Australian Virtual Herbarium and in the Western Australian Herbarium's *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 22 May 2025]. For taxa of the SWAFR, nomenclature of Provinces and Districts is given in Figure 1.

The species concept applied is both morphological and biological, following that articulated by Hopper and Brown (2001), and first used by Darwin (1868). New species are recognised if they grow in populations (i.e. are not aberrant individuals within populations displaying normal variation), if they have traits or a combination of traits not seen in any previously named species, and especially if they grow with previously named species and produce few or no natural hybrids, the latter exhibiting evidence of partial or full sterility. Ecological data, including habitats occupied, were also determined through field survey and summary of the information provided from examining herbarium specimens. In *Anigozanthos*, experimental tests of reproductive interactions of putative species were undertaken (Hopper 1980). Where this was not possible, as an independent test of reproductive isolation, we sequenced DNA from populations of putative taxa and their sisters to search for genetic divergence or uniformity, as well as to explore molecular phylogenetics (Hopper *et al.* 1999, 2006, 2009, in prep.).

We have also applied multivariate morphometrics informally or formally (as Canonical Variate Analysis described in Hopper & Campbell 1977) to test for significant shape and size variation where univariate analysis is not decisive. In one case (*Anigozanthos bicolor* Endl. and *A. decrescens* (Hopper) Hopper & R.J.Sm.), extensive population sampling for multivariate morphometrics was combined with experimental hybridization (Hopper 1980) and molecular phylogenetics (Hopper *et al.*, unpublished) to accurately map the ranges of parental taxa and their narrow hybrid zone identified first by Hopper and Campbell (1977). For the multivariate morphometrics study, stepwise elimination of 16 poor discriminatory floral characters among the 31 originally used (Hopper & Campbell 1977) to distinguish *A. bicolor* from *A. decrescens* left 15 perianth characters then measured on the extensively sampled population set (see further discussion under *A. decrescens*).

Subspecies are recognised if they form geographical or ecological races with minor morphological differences. These may hybridise and intergrade extensively where their geographical ranges overlap. Our species and subspecies concepts are thus morphological and biological, springing from approaches lucidly summarised by Grant (1971).

Hybrids are recognised with a standard formula if they are intermediate in morphology between putative parental taxa (e.g. Hopper 1977a, 1977b, 1978b). Evidence of reproductive impairments such as reduced seed set or reduced pollen fertility were also assessed where needed.

Aboriginal names, where known, are from literature or through extensive oral history interviews by SDH and colleagues with Noongar elders in the SWAFR (e.g. Meagher 1974; von Brandenstein 1988; Bindon & Chadwick 1992; Bindon 1996; Knapp 2011; Lullfitz *et al.* 2022; Knapp *et al.* 2024, and references therein).

The only unusual characters highlighted herein are in *Haemodorum* seeds, a few of which routinely exude a pale pinkish maroon pigment onto paper under sticky tape.

Conservation codes are as originally published in Hopper *et al.* (1990) and updated by the Department of Biodiversity, Conservation and Attractions today (State of Western Australia 2025; https://www.dbca.wa.gov.au/management/threatened-species-and-communities/nominations-listing).

Taxonomy

As field work, herbarium studies and DNA sequencing has progressed on Haemodoraceae over the past half-century, a sizable number of new taxa have been discovered. Progressively, these have been described, especially in the *Flora of Australia* treatment of the family (Macfarlane *et al.* 1987), and in subsequent anatomical studies and revisionary work including molecular phylogenetic investigations (Helme & Linder 1992; Hopper 1993; Maas & Maas 1993; Hopper *et al.* 1999, 2006, 2009; Le Roux et al. 2010; Barrett *et al.* 2015; Aerne-Hains & Simpson 2017; Manning & Goldblatt 2017; Hickman & Hopper 2019; Pelligrini *et al.* 2020; Macfarlane & Barrett 2025). Here the genus *Paradilatris* (Hopper ex J.C.Manning) Hopper and a range of additional new taxa and combinations in the genera *Haemodorum*, *Conostylis*, *Anigozanthos* and *Wachendorfia* Burm. are described to enable an updated annotated checklist of the family as a whole. It is noteworthy that the vast majority of new taxa are narrow endemics confined to OCBILs (Hopper 2009, 2023; Hopper *et al.* 2016, 2021; Silveira *et al.* 2021), highlighting the need for ongoing field surveys and collections in upland sandplains and hilltops in case there remain further undetected and undescribed narrow endemics in the family. We deal with taxonomic additions below alphabetically at generic rank and below, commencing with subfamily Haemodoroideae followed by subfamily Conostylidoideae.

Haemodorum

The genus *Haemodorum* consists of 36 species, including three here described as new plus three others by Macfarlane and Barrett (2025), occurring in all States of Australia except South Australia and Victoria,

with one species (*H. coccineum* R.Br.) extending into Papua New Guinea. *Haemodorum* was last revised by Macfarlane (1987a). Some of the south-western Australian bulbous species were the most important underground storage organs used as food by Noongar Aboriginal people (Lullfitz *et al.* 2022). Tropical species furnish a dye used for basket-making (e.g. Liddy *et al.* 2006; Djorrk *et al.* 2015), and the leaves of *H. coccineum*. are used to make baskets (West 1999). Toy spears are made from flowering stems of some tropical species (Karadada *et al.* 2011).

Many *Haemodorum* species are often described as having brownish black flowers but when the plants are dissected they have a kaleidoscope of colour variation. Evident colour divergence from the usual brownish black is displayed in species from the tropical north of Australia and the remarkable *H. distichophyllum* Hook. from Tasmania (Figures 2, 3).

With colleagues, we are currently writing up a molecular phylogenetic study of *Haemodorum* (see also Zuntini *et al.* 2021). This study has identified three clades that can be recognised in a subgeneric classification. Two are new and are described below. Figures 2 and 3 provide a matrix of illustrations of the various flower, fruit and vegetative parts of nine *Haemodorum* species representing each of the three subgenera (see below) to demonstrate some of this colour and morpho/anatomical variation.

Haemodorum is a relatively young genus in the family, its ancestor separating from its north-central American sister *Lachnanthes* about 35 million years ago (Hopper *et al.* 2009). Although key taxa, including *H. sandifordiae* and *H.* subg. *Gemina*, were not sampled by Hopper *et al.* (2009), the remainder of the genus *Haemodorum* began diverging about 15 million years ago.

Haemodorum subg. **Antiqua** Hopper & R.J.Sm., *subg. nov.*

Type: *Haemodorum distichophyllum* Hook.

Aerial stems 3–80 cm long. *Inflorescence* a single dense umbel-like cluster of many flowers not in pairs, 3–10 cm long, or paniculate with widely divergent dichotomous branches to 80 cm tall, with flowers solitary or in loose clusters of 2–5 concentrated at tip of branches. *Flowers* on equal pedicels. *Petals* multicoloured differing inside and out or uniformly green. *Stamens* short; anthers red or bright orange. *Style* extending well above the length of the short petals; stigma simple unbranched globular. *Seed* uniformly black. (Figures 2E, F; 3E, F)

Etymology. From the Latin adjective *antiquus, -a, -um* = ancient, in reference to the early origin of the subgenus in *Haemodorum* and the ancient divergence of its two constituent species which sit on long branches in molecular phylogenies.

Affinities and notes. This subgenus consists of two morphologically disparate species – *H. distichophyllum* from Tasmania and *H. tenuifolium* Cunn. ex Benth. from the central east coast of Australia (Figures 2, 3).

Haemodorum subg. **Gemina** Hopper & R.J.Sm., *subg. nov.*

Type: *Haemodorum spicatum* R.Br.

Aerial stems 8–230 cm long. *Inflorescence* a slender few- to many-flowered spike. *Flowers* paired, each pair on equal or unequal pedicels and spaced up to 8.5 cm apart. *Petals* uniformly black or bicoloured dark brown and black, the same colour inside and out, or multicoloured differing inside and out. *Stamens* elongate, anthers purple, white, sometimes greenish or orange. *Style* either approaching the length of the petals or much shorter (to half the length of the petals); stigma simple or trifid. *Seed* uniformly black or maroon. (Figures 2–7)

Etymology. From the Latin adjective *geminus, -a, -um* = paired, twin, alluding to the paired flowers in the inflorescence, which are found only in this subgenus.

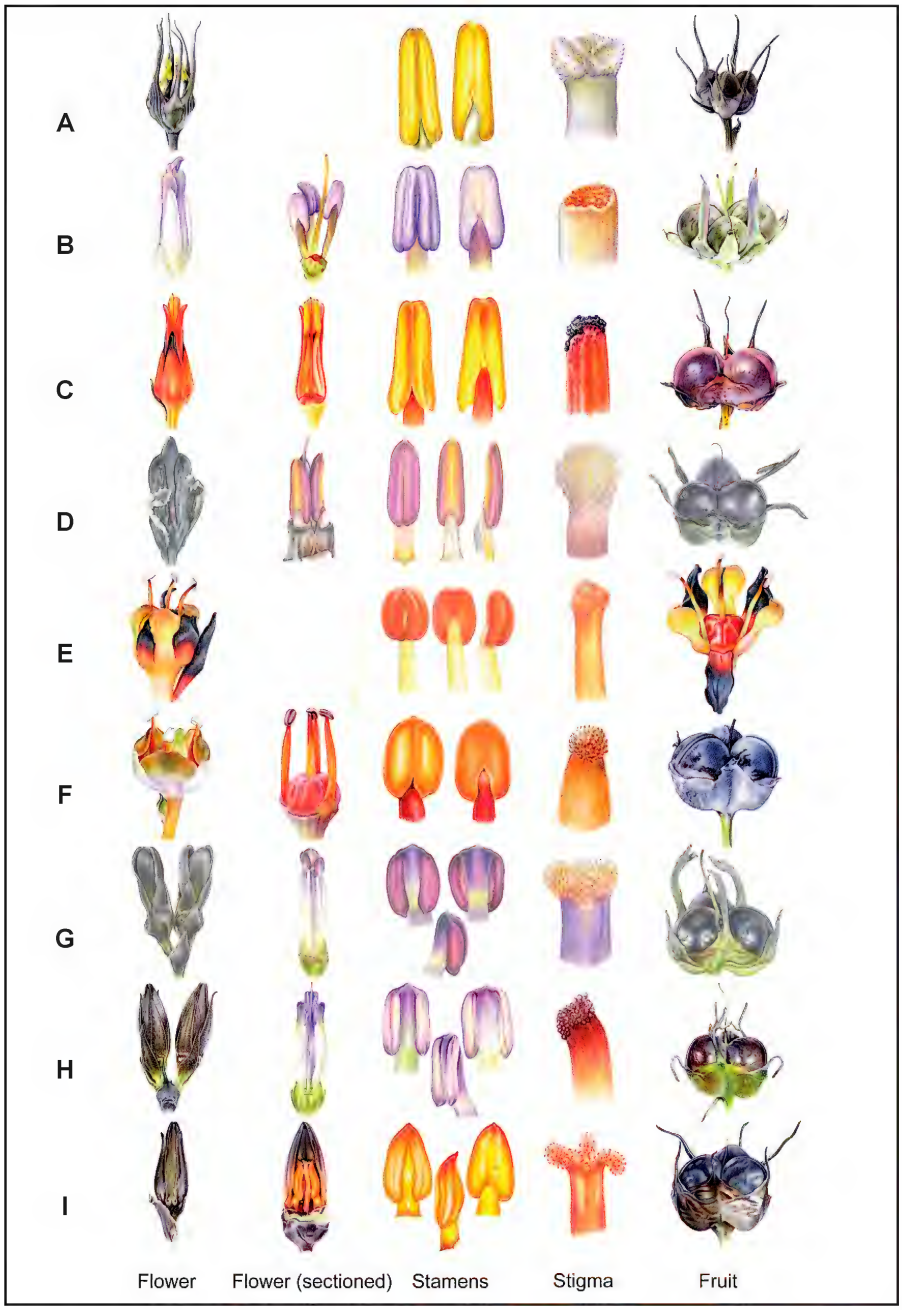

Figure 2. Flowers and fruits of *Haemodorum* species highlighting distinctive features of the three subgenera and of *H. clarksonii* and *H. sandifordiae*. A – *H. austroqueenslandicum* [subg. *Haemodorum*] Glasshouse Mountains, Qld 26° 55’16.17” S 152° 57’55.63” E; B – *H. clarksonii* [subg. *Haemodorum*] Cape York Peninsula, Qld 15° 00’43.38” S 143° 30’46.38” E; C – *H. coccineum* [subg. *Haemodorum*] Watsonville, Qld 17° 22’35.89” S 145° 18’30.02” E; D – *H. discolor* [subg. *Haemodorum*] Lake Camm, WA 32° 52’18.20” S 119° 49’20.77” E; E – *H. distichophyllum* [subg. *Antiqua*] Lake Pedder, Tas 43° 02’13.64” S 146° 16’38.57” E; F – *H. tenuifolium* [subg. *Antiqua*] Currimundi Lake, Qld 26° 45’45.82” S 153° 07’51.37” E; G – *H. brevisepalum* [subg. *Gemina*] Stirling Range, WA 34° 22’45.82” S 118° 00’20.33” E; H – *H. spicatum* [subg. *Gemina*] Narrikup, WA 34° 46’18.11” S 117° 41’47.07” E; I – *H. sandifordiae* [subg. *Gemina*] Shannon, WA 34° 43’04.36” S 116° 26’10.72” E. Illustrations, not to scale, by E.J. Hickman.

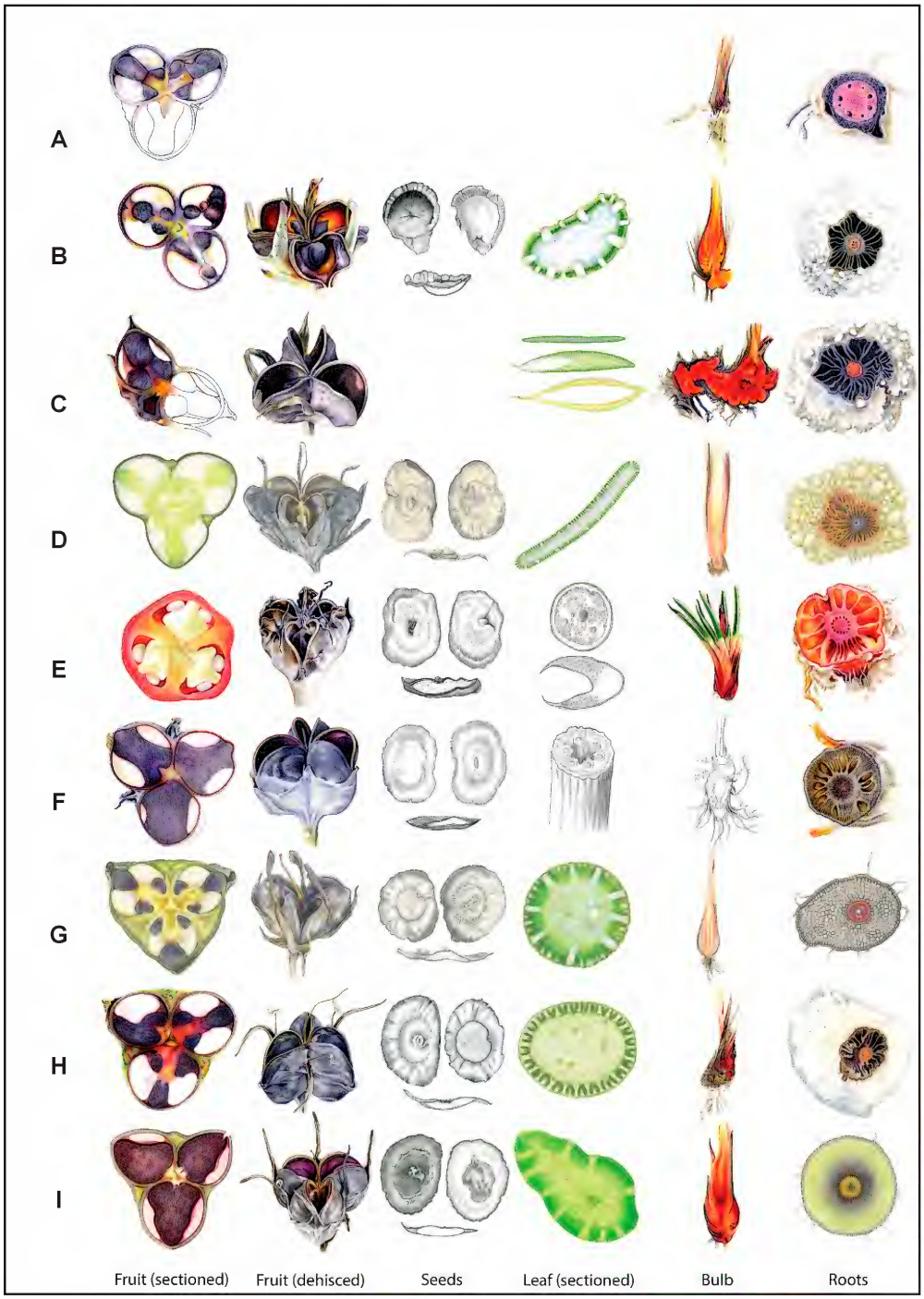

Figure 3. Colour illustrations of parts of nine *Haemodorum* species to highlight the distinctive features of the three subgenera and of *H. clarksonii* and *H. sandifordiae*. A – *H. austroqueenslandicum* [subg. *Haemodorum*]; B – *H. clarksonii* [subg. *Haemodorum*]; C – *H. coccineum* [subg. *Haemodorum*]; D – *H. discolor* [subg. *Haemodorum*]; E – *H. distichophyllum* [subg. *Antiqua*]; F – *H. tenuifolium* [subg. *Antiqua*]; G – *H. spicatum* [subg. *Gemina*]; H – *H. brevisepalum* [subg. *Gemina*]; I – *H. sandifordiae* [subg. *Gemina*]. Collection locations as in Figure 2. Illustrations, not to scale, by E.J. Hickman.

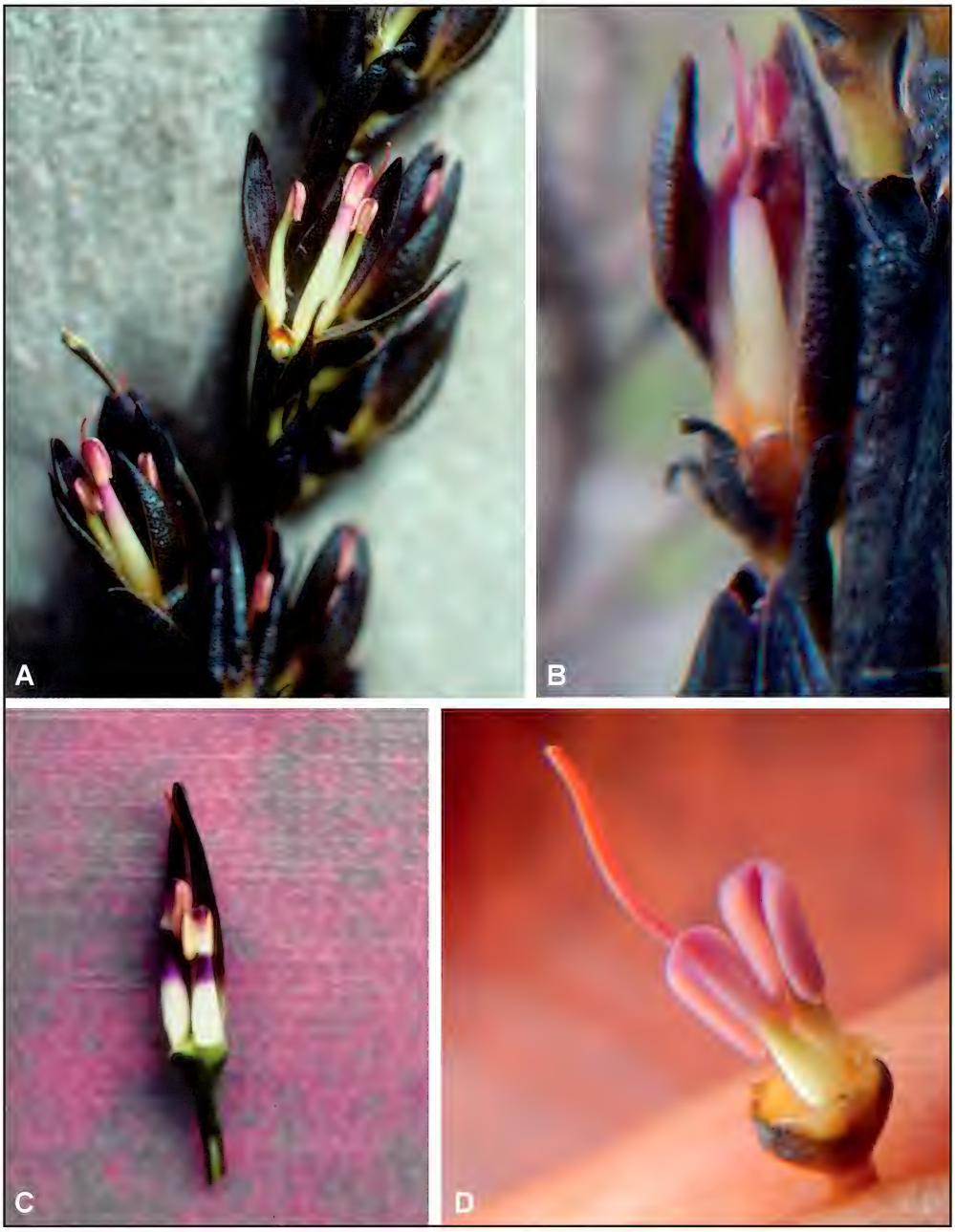

Figure 4. *Haemodorum* subg. *Gemina*. Dissected flowers exposing the purple and white/cream stamens of selected populations of *Haemodorum spicatum*. A – Mt Lindesay; B – Mt Clarence Albany, near anther shrivelled from herbivore damage; C – John Forrest National Park Perth; D – Two Peoples Bay, immature stamens not yet elongated, from a bud. Note that the south coast populations of *H. spicatum* (Mt Lindesay, Mt Clarence, Two Peoples Bay) often have the purple coloration confined to the summit of the filament adherent to the anther, and sometimes lack it altogether (see Figure 5). Photographs by S.D. Hopper.

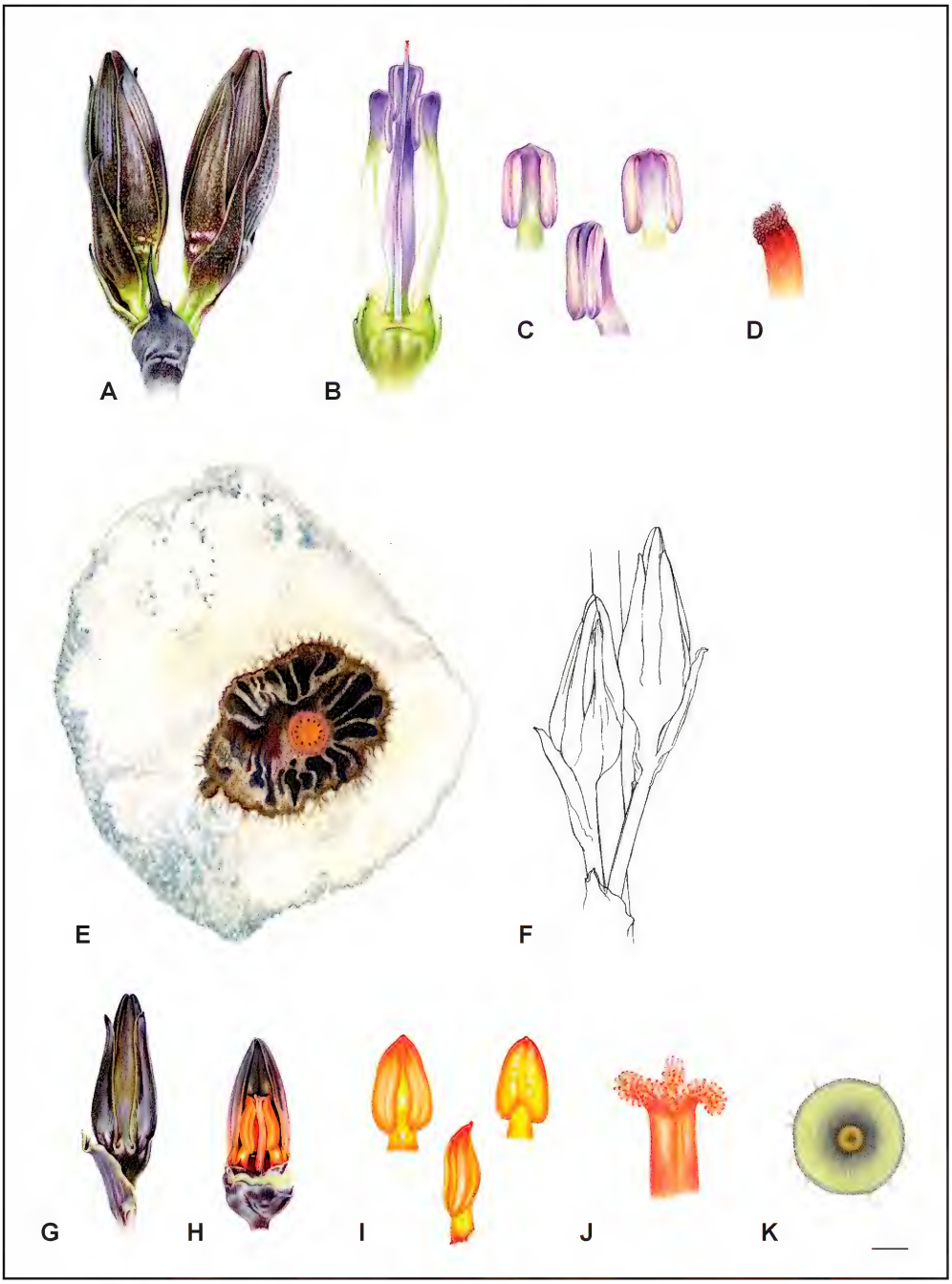

Figure 5. Comparison of character traits in *Haemodorum* subg. *Gemina* species. *H. spicatum* (A–E): A – pair of flowers showing the equal pedicels; B – gynoecium, stamens and style; C – anthers: front, back, side view; D – unlobed stigma; E – root cross-section showing sand-binding sheath called the Nan-ga by Noongars (Grey 1840) meaning 'beard of the mearn – *H. spicatum*' (ngarnak = beard, hanglet; von Brandenstein 1988). *H. sandifordiae* (F–K): F – pair of flowers showing the unequal pedicels; G – single flower; H – gynoecium, stamens and style; I – anthers: front, back, side views; J – trilobed stigma; K – root cross-section with no sand-binding sheath. Scale bars = 2 mm (A, F, G); 1.25 mm (B, H); 1 mm (C, E); 0.65 mm (I); 0.15 mm (D, J); 0.5 mm (K). Illustration by E.J. Hickman.

Affinities and notes. *Haemodorum* subg. *Gemina* contains just three species, all endemic to the Southwest Australian Floristic Region: *H. spicatum*, *H. brevisepalum* Benth. and *H. sandifordiae* Hopper & E.J.Hickman. *Haemodorum spicatum* is a species with large edible bulbs known across Noongar dialects as *miern* (Albany), *koolung* (Mingenew; Meagher 1974), *bohn* (Perth), *borana* (Margaret River), *kogarn* (Jerramungup) and *quagarn* (Esperance district; Lullfitz *et al.* 2022). The subgenus is readily diagnosed by its paired flowers, and is sister to a large clade comprising *H.* subg. *Antiqua* from Tasmania and the central eastern Australian coast and *H.* subg. *Haemodorum.*

Haemodorum sandifordiae Hopper & E.J.Hickman, *sp. nov.*

Type: North end of 'George Gardner Rock', *c.* 550 m north of Nelson Rd, 6.8 km east of Preston Rd, south-east of Shannon, Western Australia, 1 December 2015, *E.M. Sandiford* 2174, *S.D. Hopper & N.K. McQuoid* (*holo*: PERTH 08744599; *iso*: CANB, K, NSW).

Haemodorum sp. East Northcliffe (E.M. Sandiford *et al.* 2174), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 22 May 2025].

Geophyte. *Aerial stems* 85–144 cm long, usually 100 cm. *Roots* not sand-binding, almost glabrous with root hairs scarcely present to absent. *Bulb* 4.5–8 cm below soil surface, orange to red, to 15 mm diameter. *Basal leaves* 1–2; lamina orange-red to white below soil surface, green above, terete to subterete, 120–310 mm long, *c.* 1.5–2 mm wide above ground. *Inflorescence* much longer than the leaves, a slender sparsely flowered spike, rarely with one branch 1.5–9 cm long, flowers paired, up to 10 pairs on scape, the pairs widely spaced up to 8.5 cm apart. *Inflorescence bracts* with lamina greenish brown to black, narrowly triangular, 8–35 mm long, the veins obscure abaxially, margins paler, opaque, undulate, scarious. *Floral bracts* greenish black, acute, triangular with undulate opaque marginal wings, 7–10 mm long, 2–4 mm wide, reaching to ovary at anthesis. *Flowers* glossy. *Pedicels* unequal, shortest 2–4 mm long, longer 5–10 mm long. *Sepals* black to dark brown, narrowly triangular, 7–10 mm long, 2–2.5 mm wide at base, acute. *Petals* lanceolate, 7–9 mm long, 1.5–2.0 mm wide at base, abaxial surface dark brown to greenish in basal two-thirds, becoming black apically; adaxially pale orange basally, then cream, apical half dark purple-black with a few prominent vertical dark stripes. *Stamens* unequal, the longest 4 mm long, two shorter 3 mm; filaments pale orange cream, 1–2.5 mm; anthers enclosed within flower, tops reaching to mid-length of the petals, orange, 2 mm long. *Style* at anthesis reaching to top of anthers, 2.5–4 mm long, pale orange; *stigma* split into three lobes, orange. *Fruits* 3-locular, glossy blackish purple above, producing a dark red juice when squashed while immature. *Developing seeds* with white circular endosperm flanked by narrow maroon wing. *Mature seeds* uniformly maroon, circular, flat, 5–6 mm diameter, exuding a pale pinkish maroon pigment onto paper under sticky tape. (Figures 2, 3, 5–7)

Diagnostic features. *Haemodorum sandifordiae* is readily distinguished by its glabrous roots, its slender sparsely flowered spike 85–144 cm tall with paired flowers, each pair on unequal pedicels and spaced up to 8.5 cm apart, its multicoloured petals differing inside and out, its short orange stamens and style, three-lobed stigma, and uniformly maroon seed.

Other specimens examined. WESTERN AUSTRALIA: 75 km S of Manjimup on Walpole Highway, 2.2 km S of Preston Road, 300 metres E of highway, 14 Nov. 1985, *S.D. Hopper* 4728 (PERTH 01735063); Keystone Forest Block, 7 km NW of Walpole, Angove Road 1.6 km S of Logging Rd (small dam on verge) then 80 m N onto perched peat swamp, 28 June 2022, *S.D. Hopper* 8713 (PERTH 09714472); 300 m S of Nelson Road, *c.* 6.4 km W of Preston Rd, Mount Frankland National Park, SE of Shannon, 1 Dec. 2015, *E.M. Sandiford 2176, S.D. Hopper & N.K. McQuoid* (CANB, PERTH 08744505, NSW); adjacent to N end of granite outcrop, *c.* 550 m N of Nelson Road, 6.8 km E of Preston Road, SE of Shannon, 26 Jan. 2016, *E.M. Sandiford 2184, S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804672); E side Deeside Coast Road *c.* 960 m N of Chesapeake Road, 27 Jan. 2016, *E.M. Sandiford* 2186, *S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804656); *c.* 160 m E of Deeside Coast Road along old track, 200 m N of Preston Road, 27 Jan. 2016, *E.M. Sandiford* 2185, *S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804664); N side Chesapeake Road *c.* 3.3 km E of intersection with Deeside Coast road,

27 Jan. 2016, *E.M. Sandiford 2187, S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804796); 30 m W side Pingerup Road, adjacent small dam, *c.* 560 m N from intersection with Marron Road, 27 Jan. 2016, *E.M. Sandiford 2188, S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804818); *c.* 60 m SE of South Western Highway, 1.38 km from intersection with Bull Road and 1.9 km NNE of Shannon Airstrip, 27 Jan. 2016, *E.M. Sandiford 2189, S.D. Hopper, N.K. McQuoid & E.J. Hickman* (PERTH 08804826); *c.* 50 m W of Angove Road, 3.6 km from intersection with South Western Highway, NW of Walpole, 8 Apr. 2016, *E.M. Sandiford 2193* (CANB, K, PERTH 08804680).

Phenology. Flowers November–January.

Distribution. Endemic to the high rainfall region between Northcliffe and Walpole (Figure 8) in the Muir Botanical District of Gioia and Hopper (2017; Figure 1). The possibility of *H. sandifordiae* extending to peat swamps on Denbarker Road NW of Denmark needs investigation. Specimens in dehisced fruit have been seen in April. It is proposed to name the type locality as George Gardner Rock. Gardner was a well-known naturalist and anthropologist from Northcliffe, who first introduced SDH to 'his' rock containing a population of the rare species *Kennedia glabrata* Lindl. (Figure 8).

Habitat. *Haemodorum sandifordiae* occupies the most distinctive habitat for the genus within the Southwest Australian Floristic Region in being confined to waterlogged peat swamps dominated by *Homalospermum firmum*. It is often associated with *Cephalotus follicularis*, *Empodisma gracillimum*, *Cosmelia rubra*, *Reedia spathacea* (listed as Threatened – Endangered) and *Brownseya serpentina*.

Phenology. This *Haemodorum* species has been seen in flower November–January only, within a year following hot summer burns.

Etymology. Named for Elizabeth M. Sandiford (1960–), rediscoverer in 2018 of *Acacia prismifolia* E.Pritz., a plant last seen in the Stirling Range in 1933, distinguished consultant botanist, co-author of the 2011 Albany Regional Vegetation Survey and significant contributor to the Albany Regional Herbarium, who has surveyed much of the Albany district flora and beyond and is an acknowledged expert in the taxonomy and communities of south coast plants. Libby is also an enthusiastic photographer. She was the first to notice the new species on a survey of granite rocks and peatlands with SDH and landscape ecologist Nathan McQuoid in December 2015 following the big wildfire that burnt much of the Northcliffe-Walpole district in February 2015.

Conservation status. *Haemodorum sandifordiae* has been recorded at 22 locations and is usually sparsely distributed but common where it grows. Some populations occur within the WA-listed Priority One Ecological Community *Reedia spathacea - Empodisma gracillimum - Schoenus multiglumis* dominated peat paluslopes and sandy mud floodplains of the Warren Biogeographical Region, and the federally listed Threatened Ecological Community *Empodisma* peatlands of southwestern Australia (Endangered).

Feral pigs are known to have consumed bulbs (Figure 7C), and the peat swamps in which it grows are increasingly drying out with global warming, rendering them vulnerable to destruction by fire such as notably frequent prescribed burning in recent years (Bradshaw *et al.* 2018). It would be well to monitor *H. sandifordiae* in the future to ensure that it does not become a threatened species.

Vernacular name. Sandiford's Bloodroot is recommended.

Affinities and notes. The earliest collection of *H. sandifordiae* was in fruit, made in November 1985 by SDH. At the time, although the habitat was unusual, the collection was determined as *H. spicatum* by Terry Macfarlane. It was not until the species was seen fresh in flower in the wild in December 2015 that the differences from *H. spicatum* became clear (Figures 2, 3, 5). *Haemodorum sandifordiae* differs from *H. spicatum* by its glabrous roots (covered by a thick rhizosheath of root hairs in *H. spicatum*), its shorter scape averaging 1 m (up to 2.3 m in *H. spicatum*), floral pairs spaced up to 8.5 cm apart on

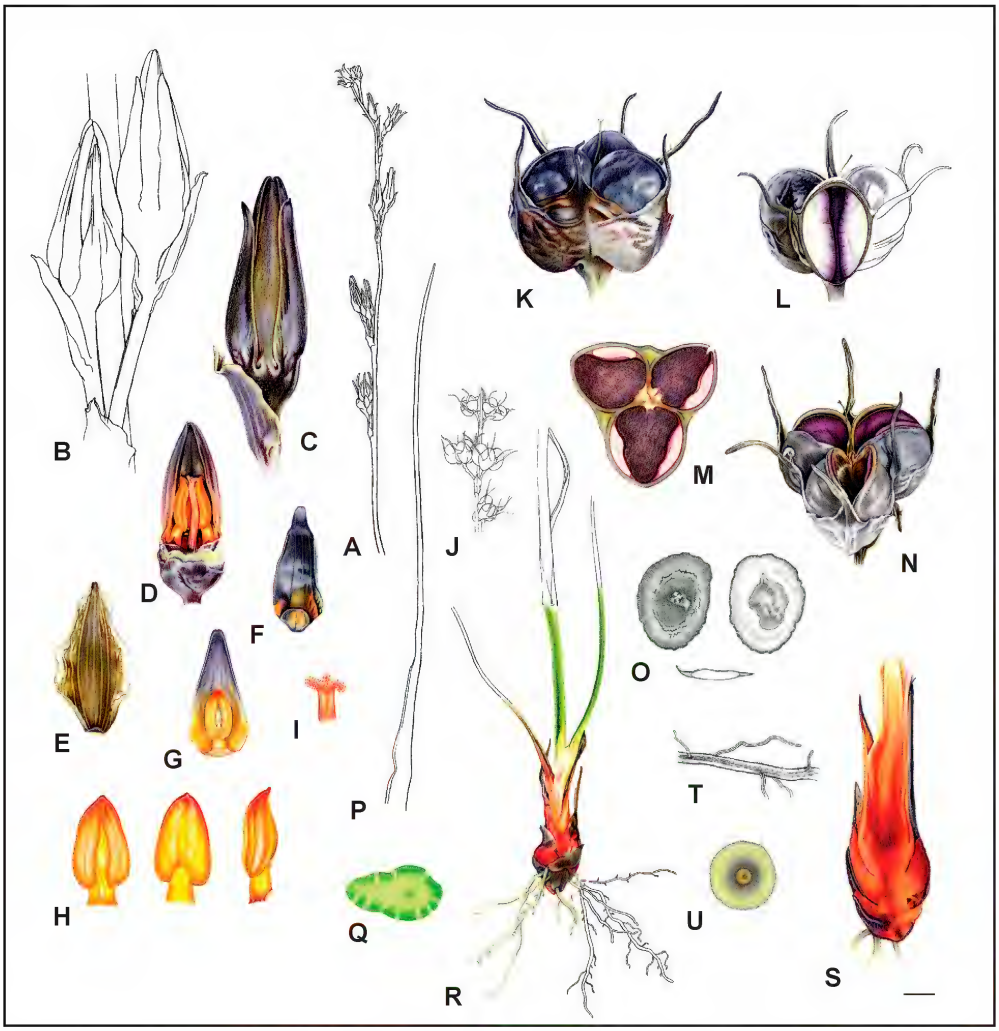

Figure 6. *Haemodorum sandifordiae* from type locality: A – flowering inflorescence; B – pair of flowers; C – single flower; D – flower with part of perianth removed to show stamens, style and ovary position; E – inflorescence bract, interior view; F – sepal; G – petal with stamen attached; H – anthers viewed from front, back and side; I – stigma; J – fruiting inflorescence; K – fruit; L – fruit with part of carpel wall removed to show developing seeds; M – cross-section through fruit to show three carpels with two maroon seeds developing in each; N – dehisced fruit; O – seeds – dorsal, ventral and cross-section; P – leaf; Q – leaf cross-section; R – below-ground parts; S – longitudinal-section through bulb; T – part of root; U – cross-section through root with no sand-binding sheath. Scale bars = 1 cm (A, J, P, R); 4 mm (S, T); 1.25 mm (B, C, D, E, F, G); 0.65 mm (H, Q); 0.4 mm (I, U); 2 mm (K, L, M, N, O). Illustration by E.J. Hickman.

the few-flowered scape (floral pairs densely aggregated on the many-flowered *H. spicatum*), pedicels of each floral pair unequal (equal in *H. spicatum*), short floral bracts with undulate opaque margins (longer floral bracts with straight margins in *H. spicatum*), multicoloured petals differing inside (3-coloured) and out (2-coloured) – uniformly coloured or 2-coloured in *H. spicatum*, its short orange stamens, and style half the length of the petals (lilac-purple anthers on longer filaments almost as long as the petals in *H. spicatum*), three-lobed stigma (undivided stigma in *H. spicatum*), and uniformly maroon seed (black in *H. spicatum*). There is a pronounced habitat difference, with *H. sandifordiae* favouring waterlogged perched peat bogs and their margins, while *H. spicatum* grows in free-draining sand on elevated slopes and hills or on the margins of, not within, peat swamps.

Figure 7. *Haemodorum sandifordiae* from type locality. A – fruiting scape alongside white inflorescences of *Cephalotus follicularis*; B – scape (to the right) and basal leaf emerging from waterlogged peaty soil adjacent to pitchers of *Cephalotus follicularis*; C – pig damage to base of scape where bulb has been dug up and bitten off; D – flowers and floral bracts revealing paler brown colour of basal two thirds of the petals; E – longitudinally sectioned flower showing unequal filaments and orange anthers; F – maroon-coloured seeds; G – squashed predehiscent fruit releasing red dye and showing immature seeds with white endosperm surrounded by maroon wing; H – Libby Sandiford holding scapes of her namesake species; I – orange-red bulb adjacent to dark brown flowers. Photographs by S.D. Hopper.

The exudation from seeds of *H. sandifordiae* of a pale pinkish maroon pigment onto paper under sticky tape is also prominently seen in the central east coast Australian species *H. tenuifolium* and, to a lesser extent, the Tasmanian endemic *H. distichophyllum*, the two species here placed in *H.* subg. *Antiqua* (Figures 2, 3). This latter species differs from *H. sandifordiae* in many ways, however, including its shorter branched inflorescence, tiny flowers, and preference for well-drained sands.

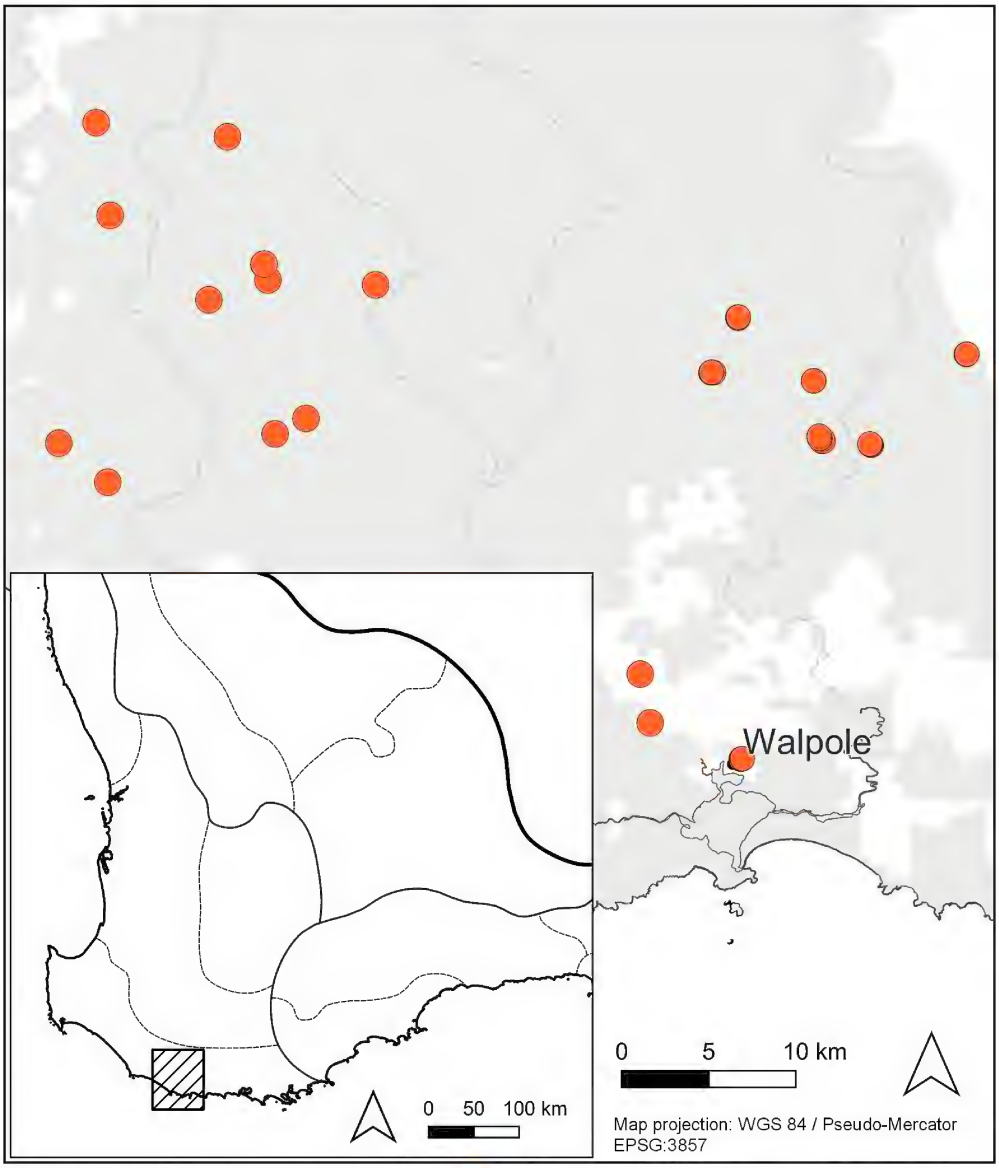

Figure 8. Distribution of *Haemodorum sandifordiae* (●) between Northcliffe and Walpole in highest rainfall peat swamps of the Muir Botanical District (Gioia and Hopper 2017). Inset map shows location in relation to Botanical Provinces and Districts recognized by Gioia and Hopper (2017) – see Figure 1.

Haemodorum sandifordiae joins many other relictual plants and animals confined to the highest rainfall parts of the SWAFR and living in wet habitats. *Cephalotus*, for example, is estimated to have diverged from its nearest relatives in the American Brunelliaceae at about 95 million years ago (Pillon *et al.* 2021).

Haemodorum sandifordiae has small edible bulbs, as do other members of the genus. There is a delay but eating a small amount leaves a tingling curry-like sensation at the tip of the tongue and back of the throat. Perhaps cooking would reduce this sensation. A tantalising comment made by the late George Gardner (pers. comm., 3 August 1987) on Marron Road 9.5 km due north of the north-west end of Broke Inlet was that the 'Aborigines used the local *Haemodorum* roots pounded into flour as a bitter laxative taken

straight'. Precisely which *Haemodorum* he was speaking of was not made clear, but *H. sandifordiae* was and is common in the area, much more so than *H. spicatum* or *H. sparsiflorum*.

Haemodorum subg. **Haemodorum**

Haemodorum clarksonii Hopper & E.J.Hickman, *sp. nov.*

Type: 0.5 km south of Watson River crossing on the Aurukun to Merluna Road *c.* 40 km north-east of Aurukun, Queensland, 2 December 1981, *J.R. Clarkson* 4044 (*holo*: BRI AQ0405383; *iso*: CNS (QRS 69946.1, MBA 7355.1, MBA 7355.2), DNA D0053837, K, MO, NT, PERTH).

Haemodorum clarksonii Hopper ms, in R.J. Smith, S.D. Hopper & M.W. Shane, *Plant Soil* 348: 467 (2011), *nomen nudum*.

Geophyte. *Aerial stems* 10–35 cm long, with inflorescence much shorter than the leaves, sometimes barely protruding from the ground. *Roots* sand-binding, to 5 cm long, 4 mm diameter. *Bulb* 10–12 cm below soil surface, dark red. *Basal leaves* 1, rarely 2 or 3; lamina orange–red to white below soil surface, green above, subterete, 10–45 cm long, *c.* 1 mm wide above ground. *Inflorescence* tightly corymbose, pyramidal, with flowers subsessile, tightly clustered on short axes 5–35 mm long, 8–12 flowers per unit, the flowers white to pale pink with darker longitudinal lines where petals exceed the sepals. *Inflorescence bracts* minute, green with scarious white fine margins and acute apex. *Floral bracts* two, slender acute, green, 3–5 mm long, <1 mm wide, shorter than individual flowers. *Flowers* 3–5 mm long; pedicel <1 mm long. *Sepals* cream to pale pink, narrowly triangular, acute, 3–4 mm long, about three quarters the length of the petals. *Petals* lilac, aging to deep purplish blue, broadly linear, obtuse, 3–5 mm long. *Stamens* lilac with the filaments white tending to lilac at the tips, unequal, one shorter than the other two, tallest pair level or half emergent from petals at anthesis; filaments 2.4–4.0 mm long; anthers lilac at anthesis, erect and held vertically, 1.0–1.2 mm long. *Style* at anthesis pale orange to cream with minute darker orange to red stigma, 3–4 mm long, equal to the petals. *Fruits* 3-locular, each member greenish to black and maturing pale bronze to dark orange-red, spherical, 2–3 mm diameter. *Seeds* black, discoid, with distinctly thickened marginal wings, *c.* 1.5–2.5 mm wide; wing 0.5 mm wide. Following dehiscence of seed, fruit has bright orange-red inner walls of the carpel cavities. (Figures 2, 3, 9–11)

Diagnostic features. Very short-scaped geophyte. This new taxon differs from *H. brevicaule* F.Muell. (Figure 11) in having white to lilac subsessile flowers instead of deep red or purplish black sessile flowers, and white to lilac stamens with one stamen shorter than the other two, instead of three yellow to red stamens that are equal in length (Figures 2, 3, 11).

Other specimens examined. NORTHERN TERRITORY: near east branch of Wildman River, Arnhem Highway, 29 Nov. 2013, *I.D. Cowie* 13660 & *N. Cuff* (BRI, DNA D0234151, SPIRIT, PHOTO at DNA; MEL 2414271A; PERTH 08837562). QUEENSLAND: Lakefield National Park, vicinity of Lake Emma, 24 Jan. 1993, *A.R. Bean* 5570 & *P.I. Forster* (BRI); 12.5 km north of Laura on the Peninsula Development Rd, 20 Dec. 1988, *J.R. Clarkson* 7704 & *V.J. Neldner* (BRI AQ0464055, DNA D0061305, L, PERTH, QRS); 6.1 km N of the North Kennedy River on the Peninsula Development Road, 20 Dec. 1988, *J.R. Clarkson* 7705 & *V.J. Neldner* (BRI AQ0464056); 0.9 km N of Big Coleman River on the Peninsula Development Rd, 21 Dec. 1988, *J.R. Clarkson* 7723 & *V.J. Neldner* (BRI AQ0464059); 13.0 km N of Musgrave Station, 10 Dec. 1983, *C.F. Puttock* UNSW 15865 (BRI, MEL 0719792A, NSW 811720, UNSWDB11421); 8.1 km SW of the Balurga turn off from the Pompuraaw Rd, 9 Dec. 2013, *S.L. Thompson* ST 13560 (BRI AQ0914496); about 17.6 km S of Piccaninny Homestead, on SE boundary of Piccaninny Plains WS with Wolverton, 9 Dec. 2013, *R. Jensen* 3079 & *J.E. Kemp* (BRI AQ0880510); 5.5km SW of Peninsula Development Rd on Dixie, 8 Dec. 2013, *S.L. Thompson* ST 13549 (BRI AQ0914495).

Phenology. Flowers December–January.

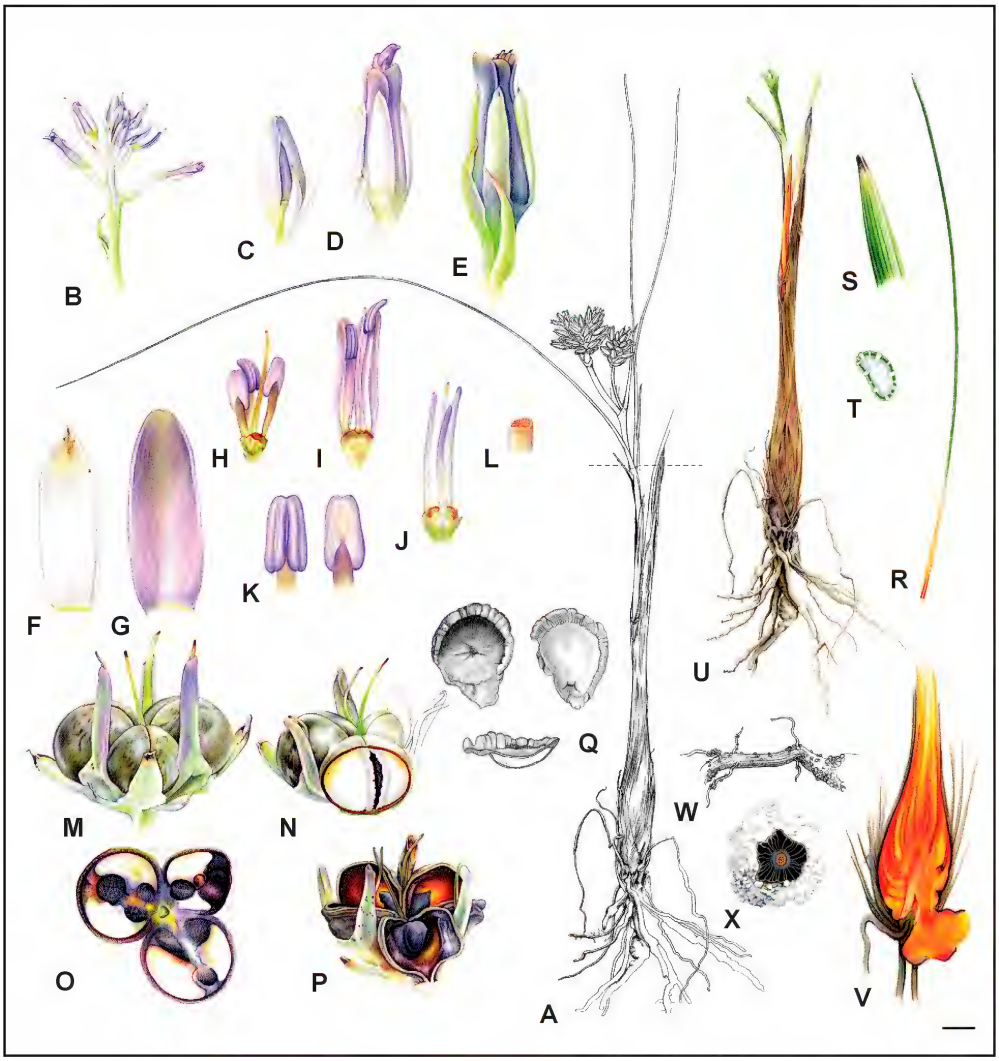

Figure 9. *Haemodorum clarksonii*. A – whole plant (dashed line represents soil level); B – inflorescence; C – flower bud; D – young flower; E – old flower; F – sepal; G – petal; H – flower with perianth removed; I – young flower with anthers attached; J – old flower with anthers detached; K – anthers viewed from front and back; L – stigma; M – fruit; N – fruit with part of carpel wall removed to show developing seeds; O – cross-section through fruit to show three carpels with two seeds developing in each; P – dehisced fruit; Q – seeds: dorsal, ventral and cross-section; R – leaf; S – leaf-tip; T – leaf cross-section; U – below-ground parts; V – longitudinal-section through bulb; W – part of root; X – cross-section through root with sand-binding sheath. Scale bars = 1 cm (A, R, U); 4 mm (B, V, W); 1.25 mm (C, D, E, H, I, J, M, N, O, P, Q, S); 0.65 mm (F, G, K, T, X); (L) = 0.2 mm. Illustration by E.J. Hickman.

Distribution. *Haemodorum clarksonii* extends across a 370 km range from the latitude of Cooktown to just north of Arukun in Cape York Peninsula, Queensland, and is known from one location near the Wildman River in Arnhem Land, Northern Territory (Figure 11).

Habitat. In Queensland the new species is found in sand in tropical grassy savannah with trees such as *Corymbia clarksoniana C. dallachiana*, *C. polycarpa*, *Eucalyptus cullenii*, *E. leptophleba*, *E. megasepala*, *E. platyphylla*, *E. tetrodonta*, *Acacia leptocarpa*, *Brachychiton diversifolius* subsp. *orientalis*, *Cochlospermum gillivraei*, *Erythrophleum chlorostachys*, *Melaleuca viridiflora*, *M. citrolens*,

Figure 10. *Haemodorum clarksonii*. A – plant and leaf; B – bulb, leaf bases and sand-binding roots; C – pig damage to *Haemodorum clarksonii* and Cockatoo grass *Alloteropsis semialata*; D – habitat near the Big Coleman River. Photographs by John Clarkson (A); S.D. Hopper (B, C, D).

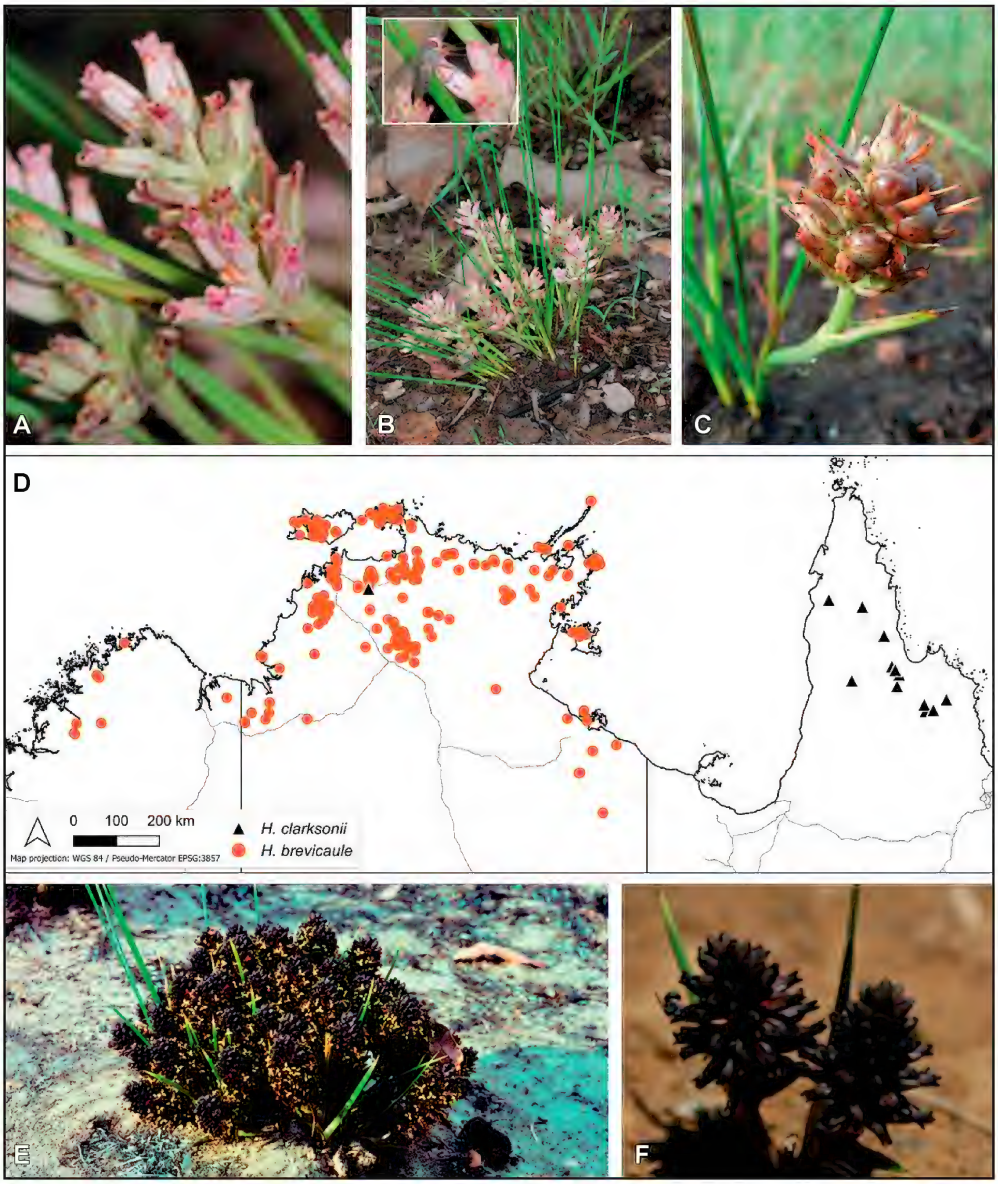

Figure 11. Geographic distributions and flowering plants of *Haemodorum clarksonii*. A – flowers; B – whole plant, inset: dipteran pollinating flower; C – whole plant in fruit; D – map showing distribution of *H. clarksonii* (▲) and its western sister species *H. brevicaule* (●); E – *H. brevicaule* habit, note the emergent yellow anthers; F – black flowers. Map derived from the Atlas of Living Australia. Photographs by Ian Cowie (A, B, D, Northern Territory); biology-assets@anu.edu.au (E); Ellen Hickman (C, Cape York).

Petalostigma banksii and *P. pubescens* (from specimen labels). Grasses recorded include *Heteropogon triticeus* and *Alloteropsis semialata* (from specimen labels). Underlying geology can be granite or sandstone.

On Artemis Station in May 2002, John Clarkson and SDH recorded *Haemodorum clarksonii* in a very open woodland of *Corymbia dallachiana*, *Eucalyptus tetrodonta*, *E. cullenii*, *Brachychiton* sp., *Melaleuca foliolosa*, *M. viridiflora*, *Alphitonia pomaderroides*, *Terminalia platyptera*, *Petalostigma banksii* and *Grevillea mimosoides* over grasses including Cockatoo Grass *Alloteropsis semialata* and Fire Grass *Schizachyrium* sp. The terrain was gradually sloping on the bank of a westward flowing creek. Tors and blocks of outcropping granite were evident. Golden Shouldered Parrots occur in this habitat and in 1993 pastoralist Sue Shepherd (pers. comm., 2002) observed these endangered birds feeding on sticky immature *Haemodorum clarksonii* fruits in the first few weeks after start of the Wet season. Their bills were stained black by the *Haemodorum* at the time.

At a second location, *c.* 300 m upslope from the Big Coleman River (Figure 10D), *H. clarksonii* was scarce in gritty sand and granite rocks in a 10–12 m woodland of *Eucalyptus tetrodonta*, *Corymbia hylandii* subsp. *peninsularis*, *C. dallachiana* and *C. clarksoniana* over *Melaleuca viridiflora*, *Grevillea pteridifolia*, *Petalostigma banksii*, *Melaleuca citrolens, Xanthorrhoea johnsonii*, *Acacia rothii*, *A. leptocarpa*, *A. calyculata*, *Grewia occidentalis*, *Exocarpos latifolius*, *Brachychiton ?heterophyllus*, *Xylomelum* sp., *Trema tomentosa* var. *aspera*, *Breynia cernua* and *Alphitonia pomaderroides* over grasses and herbs.

In the Northern Territory the habitat near the Wildman River on Arnhem Highway is given as 'in *Melaleuca viridiflora* low woodland with perennial grasses; drainage flat; poorly drained grey loamy clay (too heavy textured to support debil debil mounds)'.

Etymology. Named for John Richard Clarkson (1950–), distinguished north Queensland botanist, who has discovered many new species on Cape York and adjacent regions. Since 1979, John has been based in Mareeba in far north Queensland, working for the State government as a botanist, currently with the Queensland Parks and Wildlife Service. John has been a hospitable host during visits to the Atherton Tablelands and Cape York for field work by SDH, and also served in various capacities, including as President, for the Australasian Systematic Botany Society. He was the first to recognise this *Haemodorum* as a new species. Hence, it is fitting to name *H. clarksonii* for him.

Conservation status. Indeterminate. The species has a moderate geographical range of 370 km in Cape York and vast areas of suitable habitat exists in the vicinity of the Peninsula Development Road, as well as one location in the Northern Territory. However, detailed surveys of *H. clarksonii* are yet to be undertaken. Moreover, feral pigs target the bulbs of the species for consumption (Figure 10C). The finding of *H. clarksonii* in the Northern Territory, where it was recognised as new and labelled as *Haemodorum* sp. Wildman River (I.D. Cowie 13660 & N. Cuff), opens up the need for further survey in that disjunct region as well.

Vernacular name. Clarkson's Bloodroot is recommended.

Affinities and notes. *Haemodorum clarksonii* is a tropical species in *H.* subg. *Haemodorum*. It is recognised as a new species distinct from *H. brevicaule* from Western Australia and the Northern Territory into which specimens were previously placed. The flowers of *Haemodorum clarksonii* have white sepals that are significantly shorter than the lilac petals (Figures 9C, D, F, G; 10A). As the flower matures the sepals become greenish and the petals a deep purplish blue (Figure 9E). There are three stamens with one shorter than the other two (Figure 9H). The anthers are lilac and the filaments white tending to lilac at the tips (Figure 9H, I, K). As the flower matures the anther drops from the filament (Figure 9J). The style is white with a minute orange to red stigma (Figure 9L). The fruit is a pale green three-carpellate capsule (Figure 9M) which becomes pale bronze coloured once fully mature. When the fruit dehisces and releases its seeds it reveals the bright orange-red inner walls of the carpel cavities (Figure 9P). The discoid seeds

have distinctly thickened marginal wings (Figure 9Q). These small statured plants have a deeply buried bulb (Figure 9A), which is orange-red in cross-section (Figure 9V). The leaves are sub-terete (Figure 9T). The roots are sand-binding (Figure 9X). *Haemodorum clarksonii* differs from *H. brevicaule* (Figure 11) in having white to lilac flowers instead of deep red or purplish black flowers, and white to lilac stamens with one stamen shorter than the other two, instead of three yellow to red stamens that are equal in length.

Haemodorum clarksonii was first collected by H. Flecker from Coen Aerodrome in 1947. A number of populations of this species were found on Cape York Peninsula during the 1980s by John R. Clarkson, who recognised it as a distinct species. *Haemodorum brevicaule* occurs in Western Australia on the Mitchell Plateau, and in north and north-eastern Northern Territory, including Melville Island and Groote Eylandt, while *H. clarksonii* occurs only on Cape York Peninsula in Queensland except for the single Northern Territory location near the Wildman River on the Arnhem Land plateau (Figure 11). There appear to be no significant morphological differences between this population and those found on Cape York. Photos indicate the clearly diagnostic combination of sepals white, petals mauve to pale lilac, and stamens purple-lilac (Figure 11). No other species of *Haemodorum* has this unusual combination of colours (e.g. Figure 2, 3), although *H. spicatum* does have lilac-purple anthers.

A single hover fly (Figure 11B) is the only record of a pollinator on *H. clarksonii*.

Although *H. clarksonii* has been confused with *H. brevicaule*, recent molecular phylogenetics investigations (Hopper *et al.*, unpubl.) indicate that *H. clarksonii* is sister to a larger clade of tropical taxa including *H. coccineum*, *H. ensifolium* F.Muell., *H. interrex* R.L.Barrett & M.D.Barrett, *H. condensatum* Hopper & R.L.Barrett, *H. subvirens* F.Muell., *H. brevicaule*, *H. leptostachyum* Benth., and *H. griseofuscum* R.L.Barrett, M.D.Barrett & Hopper. *Haemodorum clarksonii* diverged from this clade about 1.7 million years ago and, thus, it is a taxonomically isolated and distinctive tropical species, as is evident from its unusual coloration of white and lilac flowers.

Haemodorum discolor T.Macfarlane

Easterly populations of this species are distinguished by their more robust, thick, dark green, shorter leaves to 30 cm long (e.g. *R.J. Smith et al.* 240, PERTH 08813280, from Boorabbin National Park) compared with the much thinner and longer-leaved type from Wannamal. Further research is recommended.

Haemodorum ghungalorum Hopper, *sp. nov.*

Type: Blackdown Tableland National Park, Stony Creek Gorge, 400 m west of carpark, Queensland, 11 November 1998, *S.D. Hopper* 8405 (*holo*: BRI; *iso*: K, MEL, NSW, PERTH 09385894).

Haemodorum gungalorum Hopper ms, in R.J. Smith, S.D. Hopper & M.W. Shane, *Plant Soil* 348: 467 (2011), *nomen nudum*.

Geophyte. *Aerial stems* 80–150 cm long, usually 80–100 cm. *Inflorescence* to 150 cm long, much longer than the leaves. *Roots* sand-binding. *Bulb* 10–15 cm below soil surface, orange-red, to 15 mm diameter. *Basal leaves* 2–4; lamina orange-red below ground to white below soil surface, green above, flat, 50–90 cm long, *c.* 2–2.5 mm wide above ground. *Inflorescence* a narrow open panicle. *Inflorescence bracts* opaque, green, narrowly triangular, 8–35 mm long, the veins obscure abaxially, margins not differentiated. *Floral bracts* black, acute, narrowly triangular, 4–7 mm long, 1–2 mm wide at base, reaching to 2–3 mm below the base of ovary at anthesis. *Buds* brownish orange near base, brownish black above. *Flowers* solitary and well-spaced, 5–20 mm apart, 5–12 flowers per unit, glossy black, especially the sepals, 8–10 mm long, sepals slightly paler than petals, faintly fragrant like antiseptic aniseed; pedicels 6–8 mm long. *Sepals* 3/4 to almost as long as petals, glossy, obtuse, narrowly triangular, 6–7 mm long, 1.5–2.0 mm wide. *Petals* obtuse, narrowly navicular, pliant, 7–9 mm long, 1.5–2.5 mm wide, glossy black, reaching 1–2 mm above the sepals. *Stamens* equal, 7–9 mm long, anthers borne near top of petals, visible and partly exposed from above at anthesis, pale yellow to gold, 2–3 mm long; filaments dark purple, 5–6 mm long. *Style* barely

shorter than petals, at anthesis reaching to middle or upper part of anthers, 7–9 mm long, purple. *Stigma* pale purple-cream. *Fruits* three locular, glossy blackish purple above, producing a dark purple juice when squashed while immature. *Seeds* black, circular, flat, 3–6 mm diameter. (Figures 12, 13)

Diagnostic features. *Haemodorum ghungalorum* may be distinguished from all other members of the genus by the following combination of characters. Geophyte, aerial stems 80–150 cm long, usually 80–100 cm. Inflorescence to 150 cm long, much longer than the leaves. Basal leaves flat, 500–900 mm long, *c.* 2–2.5 mm wide above ground. Inflorescence a narrow open panicle. Floral bracts black, acute, narrowly triangular, 4–7 mm long, 1–2 mm wide at base, reaching to 2–3 mm below the base of ovary at anthesis. Buds brownish orange near base, brownish black above. Flowers solitary and well-spaced 5–20 mm apart, 5–12 flowers per unit, glossy black, especially the sepals, 8–10 mm long, sepals slightly paler than petals; pedicels 6–8 mm long. Sepals 3/4 to almost as long as petals, glossy. Petals obtuse, narrowly navicular, glossy black, reaching 1–2 mm above the sepals. Stamens equal, 7–9 mm long; anthers borne near top of petals, visible and partly exposed from above at anthesis; filaments dark purple, 5–6 mm long. Style barely shorter than petals, at anthesis reaching to middle or upper part of anthers, 7–9 mm long, purple.

Other specimens examined. QUEENSLAND: Blackdown Tableland, South Mimosa Creek, 12 June 1977, *M.D. Crisp* 2974 (CANB CBG7703029); Blackdown Tableland, south of Dingo, 10 May 1975, *J. Donahue s.n.* (JCT-S5845.1); Blackdown Tableland, *c.* 32 km SE of Blackwater (campsite at Mimosa Creek), 0.8 km upstream from camp, elev. 600–900 m, 25 Apr. 1971, *R.J. Henderson* 847, *S.B. Andrews & P.R. Sharpe* (BRI AQ0002273); Blackdown Tableland, near old stockyard on Mimosa Creek, upstream from main N-S road, 10 Jan. 1973, *R.J. Henderson* 1397 & *P.R. Sharpe* (BRI AQ0396247; CANB 383512.1); E Blackdown Tableland National Park, Stony Creek Gorge, 400 m west of carpark, 11 Nov. 1998, *S.D. Hopper* 8404 (CANB, MEL, NSW, PERTH 09277277); Blackdown Tableland between South Mimosa Creek and Rainbow Falls, 23 Nov. 2001, *A. Worz* 23.11.17.01 (BRI AQ0847812).

Phenology. Flowers October–January, peaking in November.

Distribution. Endemic to the Blackdown Tableland (600–900 m elev.) at the north-west end of the Expedition Range, 180 km west-south-west of Rockhampton, Queensland (Figure 13B).

Habitat. Confined to grey-brown sandy loam soils within a few hundred metres of sandstone outcrops near creeklines. Grows in forest and woodland of *Blakella watsoniana* subsp. *capillata*, *Eucalyptus sphaerocarpa*, *E. longirostrata*, *E. melanoleuca* and *Livistona fulva* with an understorey of open scrub of *Acacia* spp., *Grevillea*, *Persoonia* and Fabaceae over *Themeda triandra* grassland with scattered herbs and low shrubs including *Thysanotus*, *Goodenia*, *Macrozamia platyrhachis*, *Thelymitra*, *Persoonia*, *Tricoryne*, *Poranthera* and *Dianella*.

Etymology. Named as a mark of respect for the Ghungalu people (Kangulu, Kanolu, Kaangooloo, Ghungalu and other variations), inland from Rockhampton in central Queensland, whose traditional lands include the Blackdown Tableland as well as open grassy plains and big rivers such as the McKenzie, Dawson and Comet Rivers. Rock art of Ghungalu people is a feature of the Mimosa Culture Track where *H. ghungalorum* grows.

Conservation status. *Haemodorum ghungalorum* is known from two populations 4 km apart, each of less than 50 plants. Both populations are in the Blackdown Tableland State Forest (now a National Park). Suitable habitat away from the main road and walking trails should be searched for the species. Recommended IUCN category: Data Deficient.

Vernacular name. Blackdown Tableland Bloodroot is recommended. The Tableland was given its European name in 1869 by pastoralist William Yaldwin, who named it after Blackdown House, his family home in Sussex, England. The Ghungalu people may have a name for this species.

Figure 12. *Haemodorum ghungalorum*. A – flowers and young glossy fruits; B – whole plant, 1 m tall; C – bulb and leaf bases from below ground, alongside flowers and buds; D – buds and flowers, one opened up, illustrating glossy black sepals, stamens with dark purple filaments and pale yellow anthers held with midpoints level with sepal apices, and pale purple-cream style and stigma; E – six dissected fresh flowers, each row showing (left to right) floral bract, three narrowly triangular glossy sepals, three narrowly navicular petals, three stamens and style in some cases. Photographs by S.D. Hopper from *S.D. Hopper* 8405, Blackdown Tableland National Park, Stony Creek Gorge, 400 m west of car park (type location).

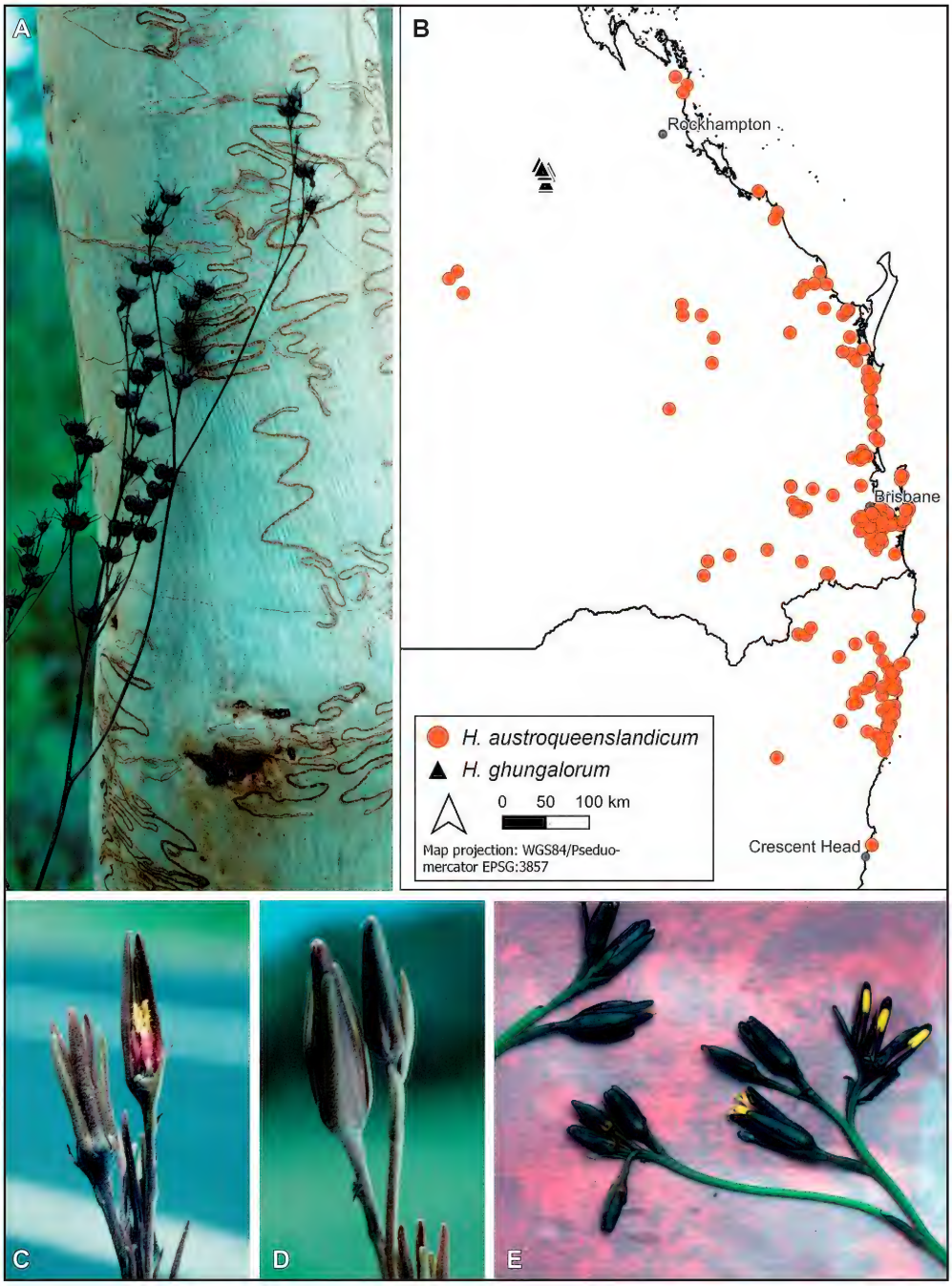

Figure 13. *Haemodorum austroqueenslandicum*: A – fruiting inflorescence against scribbly bark of *Eucalyptus racemosa*; B – geographical distribution of *H. austroqueenslandicum* (●) in south-east Queensland and north-east New South Wales (map from *Atlas of Living Australia*); C – mature flowers, one dissected to illustrate that the anthers attain only ½ the length of the petals; D – fresh flower and adjacent bud showing the greenish linear obtuse dull sepals and narrowly triangular obtuse black-brown dull petals. *Haemodorum ghungalorum*: E – flowers showing stamens about equal in length to the petals, buds; B – geographical distribution (▲). Photographs by S.D. Hopper.

Affinities and notes. Now placed in *H.* subg. *Haemodorum*, *H. ghungalorum* was first collected by Rod Henderson, S.B. Andrews and P.R. Sharpe in April 1971 in the same year as the opening of the forestry road up onto Blackdown Tableland. At the time, the species, in fruit, was regarded as *H. austroqueenslandicum* Domin (Figure 13), representing a considerable north-westerly range extension for that species. Other early collections were also in fruit only. Macfarlane (1987a: 144) consequently included *H. ghungalorum* within *H. austroqueenslandicum*, but noted that 'collections from the Blackdown Tableland, Qld, are atypical and require further study'.

In 1990, *H. ghungalorum* was seen (but not collected) growing with *Macrozamia platyrhachis* by David Jones (pers. comm., July 1998). Subsequently, SDH was able to collect flowering material of *H. ghungalorum* in November 1998 and compare it with fresh specimens of *H. austroqueenslandicum* and *H. planifolium* R. Br. within a few days. This confirmed the status of *H. ghungalorum* as a new species. Contemporary molecular phylogenetic studies (Hopper *et al.*, unpubl.) have affirmed that *H. ghungalorum* and *H. austroqueenslandicum* are sisters that diverged approximately one million years ago.

Haemodorum ghungalorum differs from *H. austroqueenslandicum* in its longer consistently narrow leaves to 90 cm, 1–2.5 mm vs 30 cm, 1.5–7 mm; floral bracts shiny and 4–7 mm long, 1–2 mm wide at base vs dull and 6–8 mm, 1 mm; flowers smaller, to 8–10 mm long vs 10–12 mm; sepals glossy black, 6–7 mm long vs dull grey-green, 9–11 mm; petals shorter, 7–9 mm vs 10–13 mm; and stamens longer with anthers partly visible atop perianth at anthesis, 7–9 mm vs 4–6 mm, not visible atop perianth at anthesis. *Haemodorum ghungalorum* is more distantly related to the *H. planifolium* group, from which it differs in its narrower leaves (1–2.5 mm vs 2–5.5 mm wide), smaller glossy black flowers (8–10 mm vs 11–16.5 mm long) with a faint antiseptic aniseed odour, vertically arranged in the slender inflorescence (vs paniculate with widely divergent branches), with stamens and style about as long as petals and sepals (vs somewhat shorter), and the anthers clearly visible and partly exposed at anthesis (vs not visible atop perianth).

Haemodorum laxum R.Br.

Atop Mt Lindesay (Western Australia), two morphs are evident (SDH unpublished observations, 28 December 1998). The typical morph grows in lateritic loam and has narrower dark green leaves 300–700 mm long, 3–7 mm wide. It grows with *Anigozanthos flavidus* in forest of jarrah and marri. A possibly undescribed morph grows in granitic sandy loam near rock outcrops. Its leaves are yellowish green, falcate or spirally twisted, and to 450 mm long, 7–11 mm wide. It grows to 50 cm tall in stunted mallee jarrah with scattered emergent *Xanthorrhoea preissii*, *Kingia australis*, *Beaufortia decussata* and *Banksia grandis* over low scrub of *Banksia*, *Dasypogon* and sedges such as *Lepidosperma hopperi*. Careful dissection of flowers revealed no distinct differences between these two morphs save more prominent venation in the bracts of the typical morph. The possibly undescribed granitic morph is illustrated in Macfarlane (1987a in Figure 53 based on Macfarlane 1583 (PERTH 0307928)) from Darling Scarp granites at Lesmurdie. Further taxonomic research is needed to ascertain the consistency of these differences between possible subspecies across the geographic range of *H. laxum.*

Haemodorum leptostachyum Benth.

Bentham (1873) named *H. leptostachyum* and *H. parviflorum* Benth. on the same page, distinguishing *H. leptostachyum* primarily by its simple scape, sometimes branching once below the middle (a panicle with racemose flowers in *H. parviflorum*), and its flowers sessile or nearly so (pedicellate in *H. parviflorum*). Macfarlane (1987a), on the basis of herbarium material, concluded that these two taxa should be treated as conspecific, and consequently synonymised *H. leptostachyum* under *H. parviflorum*.

We have been able to confirm through field work that Bentham's characters hold up in the wild. There is also a significant colour difference we have noted, with *H. leptostachyum* having bright red flowers when

fresh, while those of *H. parviflorum* are yellow (Figure 14). In addition, the two taxa occur sympatrically south of Darwin in the Virgina area and do not appear to hybridise. Based on these observations, together with an examination of the relevant types, we conclude that *H. leptostachyum* is a distinct species and warrants reinstatement.

Haemodorum parviflorum Benth. and **H. flaviflorum** W.Fitzg.

A combination of field and herbarium studies indicate that two entities (Figure 14) are included within *H. parviflorum*, represented by the two specimens Bentham (1873) cited in the protologue of this species. Cunningham's specimen from Brunswick Bay, NW coast of the Kimberley, represents a taxon subsequently named as *H. flaviflorum* by Fitzgerald (1918) based on Edkins Range material. This taxon has narrow erect panicles of many-flowered (up to 20) racemes, with scapes to 85 cm tall. Interestingly, there appear to be disjunct populations of this taxon well to the east in Arnhem Land (Figure 15).

In contrast, Schultz's Port Darwin collection cited by Bentham (1873) has shorter scapes (to 45 cm) with broader more divergently branched panicles of fewer-flowered racemes (usually 4–5, never more than 10). This taxon appears to be endemic to the Northern Territory near to Darwin (Figure 14). Moreover, it bears the closest resemblance to the protologue of *H. parviflorum* because of its few-flowered racemes and its "Panicle consisting of few, sometimes only 2 or 3 slender spreading branches'. For these reasons we lectotypify here *H. parviflorum* on the Schultz specimen and reinstate *H. flaviflorum* because this species was placed under synonymy within *H. parviflorum* by Macfarlane (1987a).

Haemodorum planifolium R.Br.

Macfarlane (1987a) mentioned variation in inflorescence form and relative dimensions of some floral parts that required further study in this species. Macfarlane and Barrett (2025) recently revised the *H. planifolium* complex and named three new species allied to *H. planifolium* – *H. brevistylum* T.Macfarlane & R.L.Barrett, *H. celsum* R.L.Barrett & T.Macfarlane and *H. collevatum* T.Macfarlane & R.L.Barrett.

Haemodorum subvirens F.Muell.

Regarded as a synonym of *H. coccineum* by Macfarlane (1987a), but reinstated by Hopper *et al.* (2009), and later accepted by Smith *et al.* (2011). Earlier collections had been made (see below), the first by A.C. Beauglehole in Western Australia in June 1976 and later by Kim Brennan of the Northern Territory's Conservation Commission, who on 23 November 1999 collected a yellowish-flowered Haemodorum while on a helicopter drop for a biological survey near Jasper Gorge in Judbarra/Gregory National Park. The species' status was confirmed when SDH, Tony Start and Trish Handasyde saw live material on 30 November 2000 also in Judbarra/Gregory National Park, Northern Territory. *Haemodorum subvirens* is easily distinguished from *H. coccineum* by its longer (to 80 cm), broader (10–12 mm wide, occasionally to 15 mm) bright green semi-glossy leaves, and its green or yellow-green flowers with prominently exserted cream anthers (Figure 16). Western Australian collections have crimson flowers with bright orange anthers and sepals, and petals green to brownish yellow basally. They may constitute a different subspecies. *Haemodorum subvirens* grows in alluvial soils along or adjacent to creeklines or seeps that are seasonally waterlogged, whereas *H. coccineum* favours better drained soils. Occurs in Western Australia and the Northern Territory (Figure 16).

Specimens examined. NORTHERN TERRITORY: Gregory National Park, south of Revolver Yards, NT/VR, 17 Apr. 1996, *R. Booth* 1750 & *M. Jones* (DNA D0130166; MEL 0252302A *n.v.*); Jasper Gorge, NT/DG, 23 Nov. 1999, *K.G. Brennan* 4282 (DNA D0143624); Gregory National Park, Joe Creek, 10 km W of the Victoria River Roadhouse, 30 Nov. 2000, *S.D. Hopper* 8522 (KPBG); Gregory National Park, 10 km NW of Victoria River Inn, NT/VR, 27 Feb. 1986, *B.G. Thomson* 1209 (DNA A0080576); Bradshaw Station, NT/DG, 3 June 1997, *G.M. Wightman* 6957 (DNA D0132701). WESTERN AUSTRALIA:

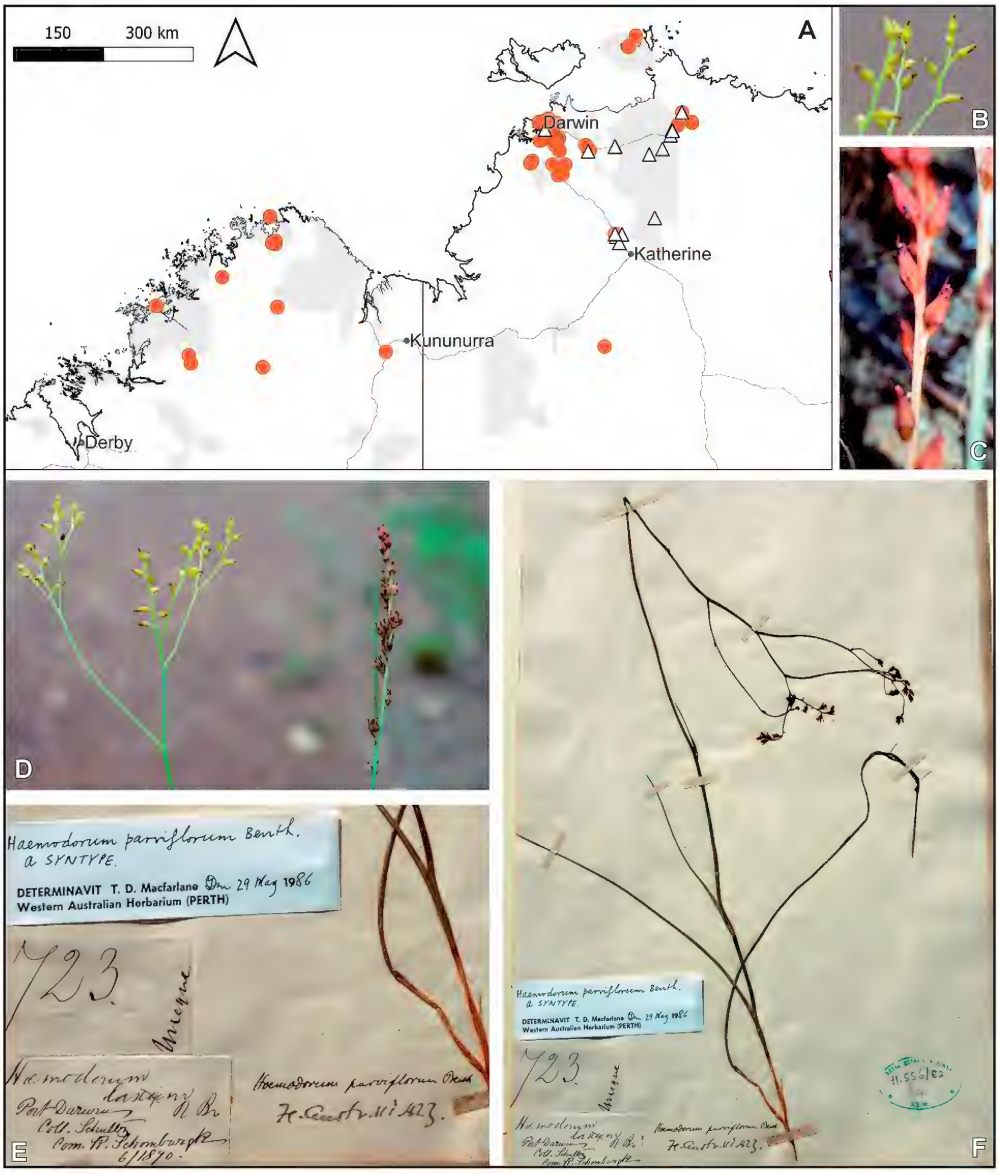

Figure 14. Comparison of floral features and distribution of *Haemodorum parviflorum* and *H. leptostachyum*. A – map of *H. parviflorum* (●) and *H. leptostachyum* (△) collections from *Atlas of Living Australia*; B – *H. parviflorum* yellow flowers; C – *H. leptostachyum* red flowers; D – *H. parviflorum* (left) and *H. leptostacyhum* (right) from sympatric populations at Virginia, NT; E – label details from a syntype of *Schultz* 723, Port Darwin collection (now the lectotype) of *H. parviflorum*; F– full sheet of the same. Photographs by S.D. Hopper.

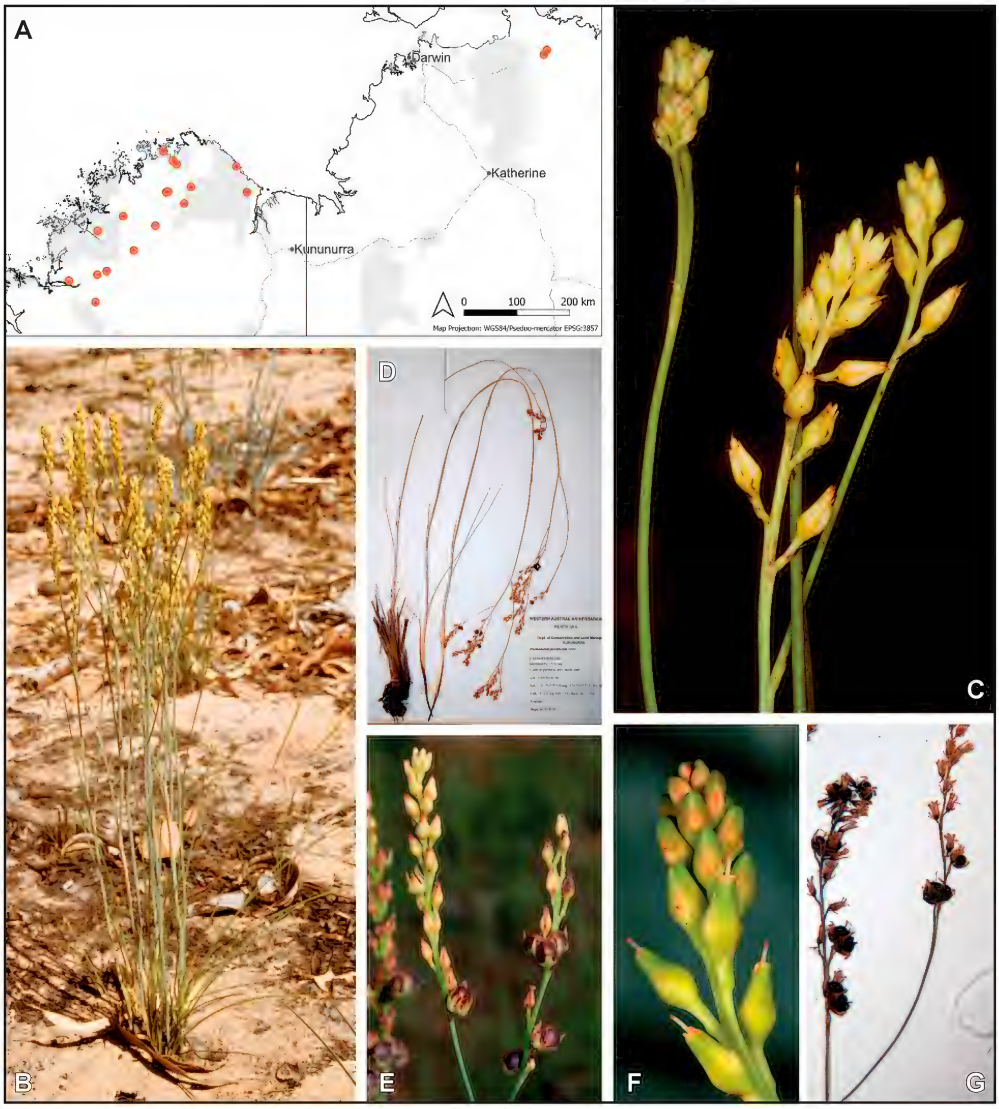

Figure 15. *Haemodorum flaviflorum*. A – distribution map of *H. flaviflorum* (●), specimen data from Atlas of Living Australia; B – plant *in situ* north of Kalumburu 2-10-96 BJC737; C – inflorescences (Princess May Range, *M.D. Barrett* 1015); D – specimen (Gibb River, *A.B. Craig* 1613); E – inflorescences (Synnot Range, West Kimberley); F – close-up of flowers (*R.L. Barrett* 5597 cultivated by R.L. Barrett, ex Drysdale River National Park); G – specimen showing inflorescence (0.8 km ENE of (new) Theda Station Homestead, *M.D. Barrett* 1120). Photographs by M.D. Barrett (C), S.D. Hopper (D, G), R.L. Barrett (E, F), B.J. Carter (B).

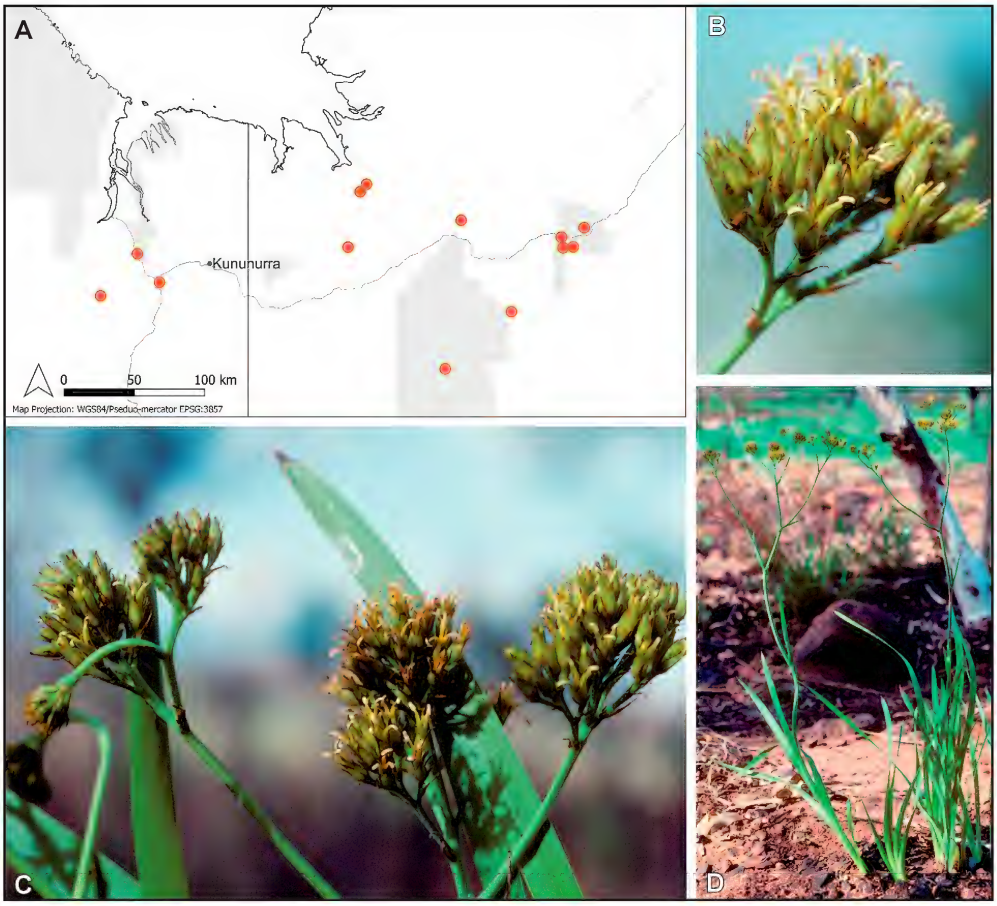

Figure 16. *Haemodorum subvirens*. A – map of geographical distribution (●) across Western Australia and the Northern Territory, modified from Australian Virtual Herbarium (accessed 13/8/2022); B – close-up of inflorescence showing the prominently exserted stamens; C – inflorescences and leaves; D – whole plant. Photographs by S.D. Hopper, taken on 30 November 2000 in the Northern Territory at Judbarra/Gregory National Park at Joe Creek, 10 km west of the Victoria River Roadhouse.

The Grotto, 2 km W of Great Northern Highway, 30 km SSE of Wyndham, Kimberley, 29 June 1976, *A.C. Beauglehole* ACB 54058 (PERTH 04964624); 7 km S of turn off from Gibb River Rd to El Questro Station HS, 15°59'S 128°01'E, 2 July 1989, *K.F. Kenneally* 10993 (PERTH 04964632); Victoria Highway, 11.2 km W of Weaner Creek, 27 Dec. 2000, *A.N. Start* ANS 1349 (PERTH 09021302).

Dilatris and Paradilatris

Dilatris P.J.Bergius is a small genus of three species endemic to the Cape Region of South Africa – *D. corymbosa* P.J.Bergius, *D. ixioides* Lam. (Figure 17) and *D. pillansii* W.F.Barker. Until now, a fourth species, *D. viscosa* L.f. has been regarded as an aberrant species of the genus, sufficiently distinct to merit recent subgeneric status as *Dilatris* subg. *Paradilatris* Hopper ex J.C.Manning (Manning & Goldblatt 2017). Early molecular phylogenetic analyses failed to resolve the position of *D. viscosa* versus other members of the genus (Hopper *et al.* 2009; Zuntini *et al.* 2021). Here, based on recent unpublished molecular phylogenetic studies that affirm that the species is sister to the other three, but morphologically and phylogenetically distinct, the new genus *Paradilatris* (Hopper ex J.C.Manning) Hopper is erected to

bring the classification of these two clades in line with others in Haemodoraceae such as *Anigozanthos* and *Macropidia,* which similarly differ fundamentally in floral morphology and fruit dehiscence.

Dilatris P.J.Bergius, *Descr. Pl. Cap.*: 9, t. 3, Figure 5 ([Sep.] 1767). *Type*: *Dilatris corymbosa* P.J.Bergius

Paradilatris (Hopper ex J.C.Manning) Hopper, *stat. nov.*

Basionym: *Dilatris* subg. *Paradilatris* Hopper ex J.C.Manning, *S. Afr. J. Bot.* 113: 104 (2017). *Type*: *Paradilatris viscosa* (L.f.) Hopper.

The new genus *Paradilatris* is monotypic. It differs from *Dilatris* (Figures 17, 18) in having narrow yellow perianth segments rather than broad, lilac perianth segments. *Dilatris* have three stamens, with one yellow anther and two red anthers. *Dilatris ixioides'* yellow anthers are distinctly larger than the red anthers, while the yellow and red anthers of *Paradilatris viscosa* are essentially equivalent in size. The filaments of *D. ixioides* are all cream with a tinge of orange. The filaments of *P. viscosa* are yellow for the yellow anther, and red for the red anthers. The style of *D. ixioides* is cream with a tinge of orange. The style of *P. viscosa* is red. The stigma of *D. ixioides* is red and tuberculate. The stigma of *P. viscosa* is red and glabrous. The hairs of *D. ixioides* are tapering. The hairs of *P. viscosa* are topped with a gland filled with orange-coloured oil. As noted by Barker (1940), in *P. viscosa* the narrow perianth segments are persistent when the flower matures to a fruiting capsule. To disperse the seeds, the capsule splits from the apex halfway down the junction of the carpels. The carpel walls spread apart leaving the central column free at the apex, and a single ovule in each of the three carpels matures to a discoid seed. The seeds detach and are shaken out of the capsule, while the capsule remains intact.

In *Dilatris* species, with broad perianth segments, the perianth becomes papery and aids in seed dispersal by acting as a parachute. Usually only one of the three carpels has an ovule that matures to seed, while the other two carpels are aborted. The ovule matures to fill the entire carpel cavity and is clasped by a flange, formed from the pericarp, which projects inwards round the entire edge of each carpel. The carpel wall containing the ripe seed, held in place by the flange, begins to separate from the receptacle, starting at the base of the fruit, and continuing upwards, until it finally breaks away completely with the perianth attached at the apex, forming a parachute suitable for wind dispersal.

Etymology. From the Greek *para-* = by the side of, near, compared with, alluding to the sister relationship with *Dilatris.*

Affinities and notes. Although recent phylogenetic analyses firmly show that *Paradilatris* and *Dilatris* are sister groups, the classification of the former as a separate genus is somewhat controversial (APG IV 2016; Zuntini *et al.* 2021). Indeed, Manning (in Manning & Goldblatt 2017) erected *Paradilatris* as a subgenus within *Dilatris* after discussion with SDH on its placement in molecular phylogenies prior to the most recent study (Hopper *et al.*, in prep.). The latter unequivocally placed *Paradilatris* as sister to the other three species of *Dilatris*. This molecular evidence, combined with the extensive morphological differences between the two taxa illustrated in Figures 17 and 18, argue for their separation. Moreover, as noted above, the treatment herein is consistent with the tradition of monotypic sister genera to more species-rich genera that are recognised widely in Haemodoraceae. Classification has to recognise long branches and anagenesis, not solely cladogenesis, if the richness of evolutionary trends is to be more fully expressed in taxonomy.

Paradilatris viscosa (L.f.) Hopper, *comb. nov.*

Basionym: *Dilatris viscosa* L.f., *Suppl. Pl.* 101 (1781 [Apr. 1782]). *Type*: South Africa, Western Cape, 'Cap. bonae spei.' ['in summitate Taffelberg [Table Mt] prope frontem' *fide* Thunberg (1807)], *Thunberg s.n.* (*holo*: LINN [LINNHL63-3] image!; probable *iso*: UPS-THUNB [1237] microfiche!).

Figure 17. Yellow and red-flowered *Paradilatris viscosa* at Highlands, Kogelberg Nature Reserve, South Africa (A, B) and purple-flowered *Dilatris ixioides* with yellow and red coloured uneven anthers in the Cederberg south of Algeria, South Africa (C, D). Photographs by S.D. Hopper.

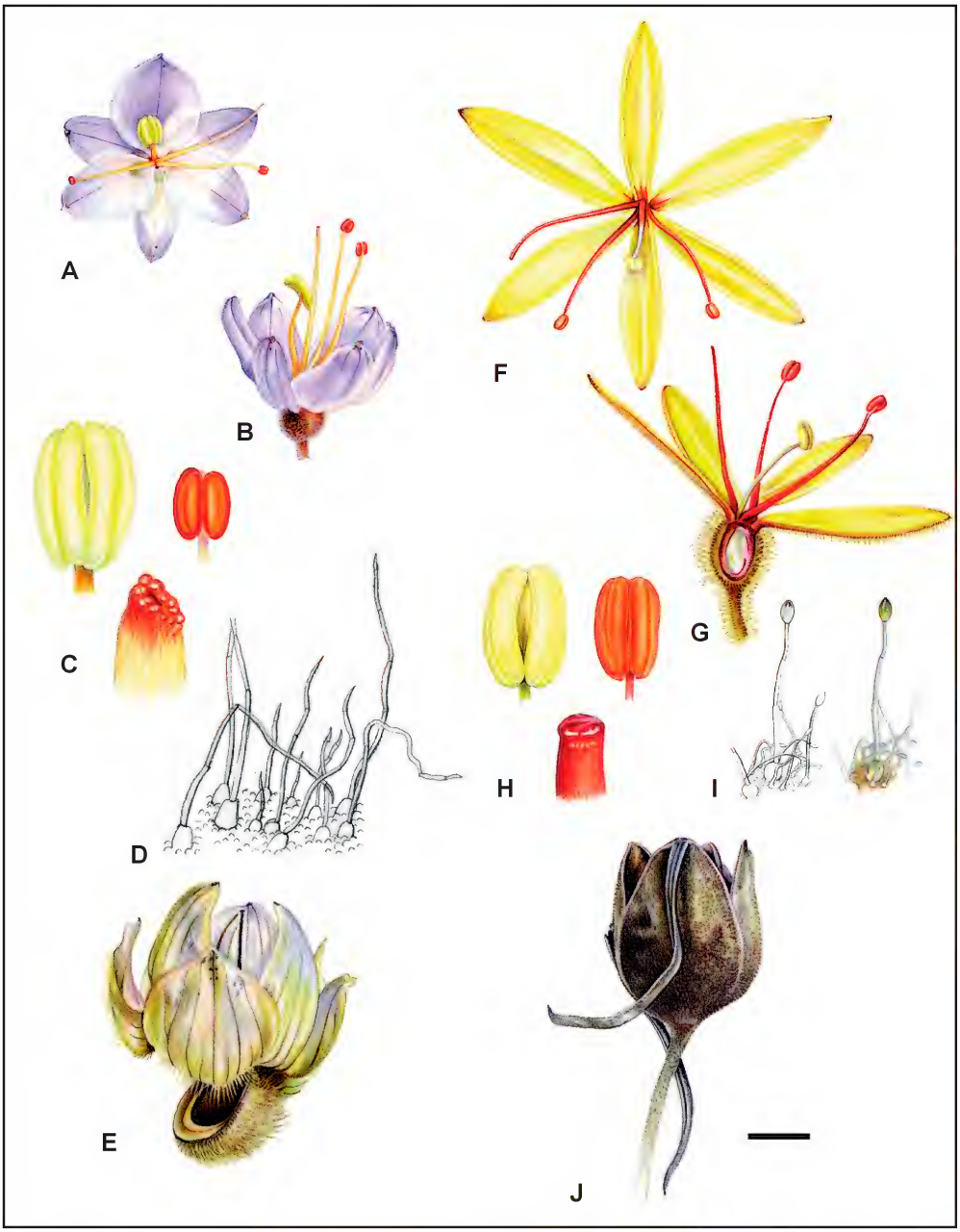

Figure 18. Comparison of floral features and fruits of *Dilatris* (left) with *Paradilatris* (right). *Dilatris ixioides*: A – flower viewed from top; B – flower viewed from side; C – anthers and stigma; D – tapering hairs; E – *Dilatris pillansii*, mature fruit; *Paradilatris viscosa*: F – flower viewed from top; G – flower viewed from side; H – anthers and stigma; I – glandular hairs; J – mature dehiscent fruit. Scale bars = 4 mm (A, B, F, G); 1 mm for anthers (C, H); 0.2 mm for stigma (C, H); 0.4 mm (D); 2.5 mm (E, J); 0.3 mm (I).

Wachendorfia Burm.

Wachendorfia is a small genus of five species recognised herein, all endemic to the Greater Cape Floristic Region of South Africa (*sensu* Born *et al.* 2007). The yellow flowers have a form of dimorphic enantiomorphy (directional asymmetry of the style and upper anther) with left- and right-handed flowers (e.g. Figures 19, 20) that has attracted considerable attention in recent years (Ornduff & Dulberger 1978; Jesson & Barrett 2002; Karron *et al.* 2021; Minnaar & Anderson 2021). Indeed, more recent exploration of this rare reproductive system in *Wachendorfia's* monotypic sister genus *Barberetta* Harv. further elaborates on enantiostyly as a feature in Haemodoraceae (Johnson *et al.* 2023).

Within *Wachendorfia*, polymorphism is pronounced in *W. paniculata* Burm. (Figure 20), whose species' limits were described as 'vague' (Helme & Linder 1992). Furthermore, *W. paniculata* was considered 'exceptionally variable with respect to plant size, leaf hairiness and shape, and flower size and structure. This has resulted in the large number of synonyms for this species' (Helme & Linder 1992: 64).

When discussing variation in *W. paniculata*, Helme and Linder (1992) picked up on three 'forms' previously identified by Barker (1950) in her treatment of Haemodoraceae for the *Flora of South Africa* and relevant sketches and descriptions deposited in the Compton Herbarium. A particularly relevant discussion to the taxonomy adopted herein relates to Form 2, described by Helme and Linder (1992: 65) as:

'Form 2: specimens from the mountains between Ceres and Pakhuis Pass are frequently very tall, with extremely lax panicles and long, thin leaves. This form does have a degree of environmental and geographical correlation, which suggests that it might be viewed as a subspecies (allopatric, genetically similar). However, the form is not strictly allopatric as the typical form of *W. paniculata* is known to occur in the area and for this reason we would not recommend the use of a formal subspecific rank for this taxon.'

However, this assessment did not consider an alternative hypothesis – that Form 2 is in fact a distinct species from *W. paniculata*. If so, this would explain the occasional sympatry of Form 2 with typical *W. paniculata*. SDH encountered Form 2 in fieldwork commencing in 1998 (e.g. Figures 19, 20; Table 1), and over the next two decades examined relevant specimens of Form 2 (= *W. laxa* herein) and *W. paniculata* in flower along a south-north transect from Kleinmond to Clanwilliam (Figure 20). This analysis established the presence of two distinct taxa that occasionally hybridise when sympatric. This view was adopted previously by Taylor (1996: 49) who listed *W. paniculata* and *W. laxa* W.F.Barker ms (= manuscript name) as both occurring in the Cederberg flora. However, a subsequent treatment by Goldblatt and Manning (2002) abandoned Barker's manuscript name of *W. laxa* for Form 2, acknowledging that while it appeared distinctive, a detailed study of morphology and genetics was required to ascertain its virtue as a recognised species (pers. comm., 1998 *et deinde*). Sufficient evidence is now at hand to formally name Form 2 as *W. laxa*.

Wachendorfia laxa W.F.Barker ex Hopper, *sp. nov.*

Type: Mitchells Pass near railway crossing, Ceres Conservation Park, South Africa, 12 November 1959, *W.F. Barker* 9104 (*holo*: sheet I, NBG; *iso*: sheets II, III, NBG).

Wachendorfia laxa Hopper ms, in R.J. Smith, S.D. Hopper & M.W. Shane, *Plant Soil* 348: 468 (2011), *nomen nudum*.

Slender rhizomatous perennial *geophyte*, 40–100 cm tall, usually 50–80 cm. *Rhizome* ovoid, up to 50 mm in diameter, appearing tunicate when dry. *Leaves* annual, plicate; often falcate and acute with a sudden narrowing forming a long petiole, or narrowly lanceolate or linear to broadly falcate, erect or spreading, bright glossy green, scarcely pleated, almost glabrous with few slender hairs, 3-nerved; 14–33 cm long, 0.6–2.1 cm wide, much shorter than scape, pliant when bent. *Scape*/*culm* 3–15 mm diameter, green to

Table 1. *Wachendorfia laxa* and *W. paniculata* populations (see map Figure 20) scored for morphology over the period 1998–2008 in a south–north transect from Kleinmond to Clanwilliam, South Africa.

Taxon	Pop	Date	Location	Lat.	Long.	Flower colour	Leaf length (cm)	Leaf width (cm)	Scape height (cm)
paniculata	1	10 09 1998	Sir Lowry Pass Rd footslope	34°07'52.26"S	18°34'34.60"E	pale yellow	23.5	1.8 – 3.3	20–40
paniculata	2	13 09 1998	Breede River flats SW of Worcester	34°40'14.22"S	19°24'50.54"E	pale yellow	30	2.1–2.7	na
paniculata	3	13 09 1998	8 km SW of Villiersdorp, Draaiberg farm entry	34°01'23.08"S	19°13'12.15"E	pale yellow	10.5–12	1.8–2.3	15–30
paniculata	4	13 09 1998	Threewaterkloof Dam 1.1 km NW of R321 on R45	34°01'00.93"S	19°12'25.34"E	pale yellow	na	na	na
paniculata	5	13 09 1998	Threewaterkloof Dam 3.6 km NW of R321 on R45	34°00'08.10"S	19°11'17.22"E	pale yellow	na	na	na
paniculata	6	27 08 2002	Klipheuwel 1.5 km W of on Philadelphia Road	33°42'16.68"S	18°14'00.06"E	fawnish creamy yellow	13	1.4	na
paniculata	7	10 09 2007	top of Verrfeld Pass 6.5 km NNW of Picketberg	32°50'59.53"S	18°44'00.24"E	yellow	18.5	0.5	20
paniculata	8	02 11 2008	Kleinmond, 1.2 km NW of Harbour	34°20'21.96"S	19°00'12.57"E	pale yellow	18	0.7	25
paniculata	9	02 11 2008	E of Pringlebaai, Nature Reserve SE of X roads on R44	34°20'26.57"S	18°50'42.22"E	pale yellow	na	na	na
paniculata	10	06 11 2008	Franschoek Pass Rd 1.5 km N of Jan Joobertsgard Bridge	33°55'44.26"S	19°09'36.38"E	pale yellow	19	1.5	30
laxa	1	11 09 1998	Pakhuis Pass 5 km E of Sevila Rock Art trail	32°04'13.57"S	19°07'26.44"E	gold	19–30	0.9–1.1	40–50
laxa	2	30 08 2002	250 m E along R366 from R365, Het Kruis, 34 km N of Piketberg	32°36'24.80"S	18°45'05.70"E	gold	25	2.1	50–70, 80, 90
laxa	3	05 01 2004	Bains Kloof walk-trail to Bobbejans Waterfall	33°36'52.58"S	19°06'59.94"E	golden yellow	14.5	0.6	70
laxa	4	10 09 2007	2.3 km due N of Clanwilliam Dam	32°09'51.06"S	18°52'20.42"E	golden yellow	30	1.9	80
laxa	6	07 11 2008	Rietvlei turn off, N7, 20 km NNW of Clanwilliam	32°01'15.68"S	18°46'59.27"E	gold	26	1.4	40–90
laxa	7	07 09 2010	Olifants Rivier, Algeria Brug, 21.5 km SSE of Clanwilliam	32°21'54.29"S	18°56'58.87"E	gold	32.5–33	1.5	50–100
laxa × *paniculata*	5	06 11 2008	Franschoek Pass Rd 11.4 km WNW of Villiersdorp	33°58'11.22"S	19°10'01.18"E	gold, yellow	14	1.5, 2.1	30–60

brown, densely hirsute with a short simple-haired indumentum. *Inflorescence* a lax racemose panicle comprising 5–20 cymes, each cyme few-flowered (1–5, occasionally to 10). *Peduncles* up to 7.5 cm long, unbranched; pedicels short (less than 4 mm long). *Flowers* lacking an odour. *Tepals* gold, 20–30 mm long, 11–14 mm wide; inner abaxial tepal same size as the rest; outer adaxial tepal darker brownish gold, shorter (16–20 mm) and narrower (8–10 mm) than the rest, sometimes recurved, margins fringed and densely hirsute with short silvery hairs. *Nectar guides* on upper tepals pale yellow, rimmed by darker gold to yellow-brown colouration. *Stamens* three quarters to tepal length, spreading; filaments 18–20 mm long; anthers 1.5–2.5 mm long, 1 mm diameter. *Style* 18–22 mm long. Young fruits with red-vermillion wings. (Figures 19, 20)

Diagnostic features. Slender geophyte usually 50–80 cm tall, sometimes 40–100 cm. Leaves bright glossy green, almost glabrous with few slender hairs, much shorter than scape, scarcely pleated, pliant when bent. Cymes usually few-flowered (1–5), occasionally to 10. Peduncles up to 7.5 cm long, unbranched; pedicels short (less than 4 mm long). Tepals gold, 20–30 mm long, 11–14 mm wide; outer adaxial tepal darker brownish gold, shorter (16–20mm) and narrower (8–10 mm) than the rest, sometimes recurved, margins fringed and densely hirsute with short silvery hairs. Nectar guides on upper tepals pale yellow, rimmed by darker gold to yellow-brown colouration. Anthers 1.5–2.5 mm long, 1mm diameter. Style 18–22 mm long. Young fruits with red-vermillion wings.

Other specimens examined. SOUTH AFRICA: Pakhuis Pass, *W.F. Barker* 285 (NBG); Olifants Rivier Dam, *W.F. Barker* 5741 (NBG); Ceres Wildflower Show, *R.H. Compton* 6335 (NBG); Mitchells Pass, Ceres Conservation Park, 6 Oct. 1941, *R.H. Compton* 11968 (NBG); Tulbagh Waterfall, *R.H. Compton* 12411 (NBG); Jonkershoek, *R.H. Compton* 15276 (NBG); Pakhuis Pass, 1940, *E.E. Esterhuysen* 3173 (NBG); Bidouw valley, *P. Goldblatt & J.C. Manning* 9394 (NBG); Jonkershoek, *R. Haynes* 1122 (NBG); Jonkershoek State Forest Upper Valley, *E. Kruger* 55 (NBG); Bidouw valley, *A. Middlemost* 1752 (NBG); N. Cederberg, Hueningvlei Mission settlement, roadside seepage (*Elegia capensis*) along river, locally common, 4 Nov. 1984, *H.C. Taylor* 11141 (NBG); between Heuningvlei and Pakhuis Pass, *c.* 850m, moist levelish ground near lowest point along jeeptrack, 22 Sep. 1985, *H.C. Taylor* 11376 (NBG); Devil's Tooth, Groot Drakenstein Mountains, *E. Wasserfall* 720 (NBG).

Phenology. Flowers mainly September–November, sometimes at high altitudes into January.

Distribution. *Wachendorfia laxa* has a north–south distribution with a possible disjunction in the middle of its 240 km range, which extends from Jonkershoek and Franschoek Pass Road to Mitchell's Pass in the Cape fold mountains and then from the Picketberg north to Clanwilliam on the N7 highway and adjacent Cederberg mountains to the east (Figure 20).

Habitat. Northern Cederberg populations favour incised mountain passes and river valleys or seasonally moist sites. Grows often near exposed rock outcrops in seasonal water discharge areas or in seasonally sodden clay loam adjacent watercourses in fynbos of *Protea nitida*, *Crassula extensa*, *Trachyandra divaricata*, *Montinia caryophyllacea*, *Didelta spinosa*, *Zygophyllum* sp., *Ornithogalum thyrsoides*, *Eriocephalus africanus*, *Dicerothamnus rhinocerotis*, *Euphorbia mauritanica*, and *Euryops speciosissima*. Southern populations on mountain slopes grow in fynbos with *Tetraria thermalis*, *Elegia capensis*, *Protea nitida*, *Metallasia barnardii*, *Crassula dejecta*, *Nivenia corymbosa*, *Cymbopogon marginatus*, *Ursinia crithnoides*, *Arctotis flaccida*, *Heterolepis aliena*, *Gnidia oppositifolia*, *Erica pinea*, *E. bergiana*, *Disa atricapilla*, *Corymbium villosum*, *Pseudoselago serrata*, *Watsonia schlechterii*, *Therianthus minutus* and *Psoralea restioides*.

Etymology. From the Latin *laxus, -a, -um*, meaning loose, flaccid, with parts distinct and apart from one another or in an open or loose arrangement, alluding to the relatively few-flowered, tall, open inflorescence compared with the compact, many-flowered, short *W. paniculata* (Figures 19, 20).

Figure 19. *Wachendorfia laxa* population l4 (see Figure 20) 2.3 km due north of Clanwilliam Dam on the Oliphants Rivier, slopes beside the N7 highway, South Africa. Note the tall slender scapes, golden yellow flowers with faint green nectar markings and green almost hairless leaves. Photographs by S.D. Hopper.

Conservation status. *Wachendorfia laxa* seems to be sporadic in occurrence, although locally abundant where it occurs. Moreover, the locations it occupies in the Cedarberg and Cape Fold Mountains are, in places, difficult to survey. At this stage, given its occurrence in several conservation reserves there, *W. laxa* appears not to be facing any major threats.

Vernacular name. Lax Wachendorfia is recommended.

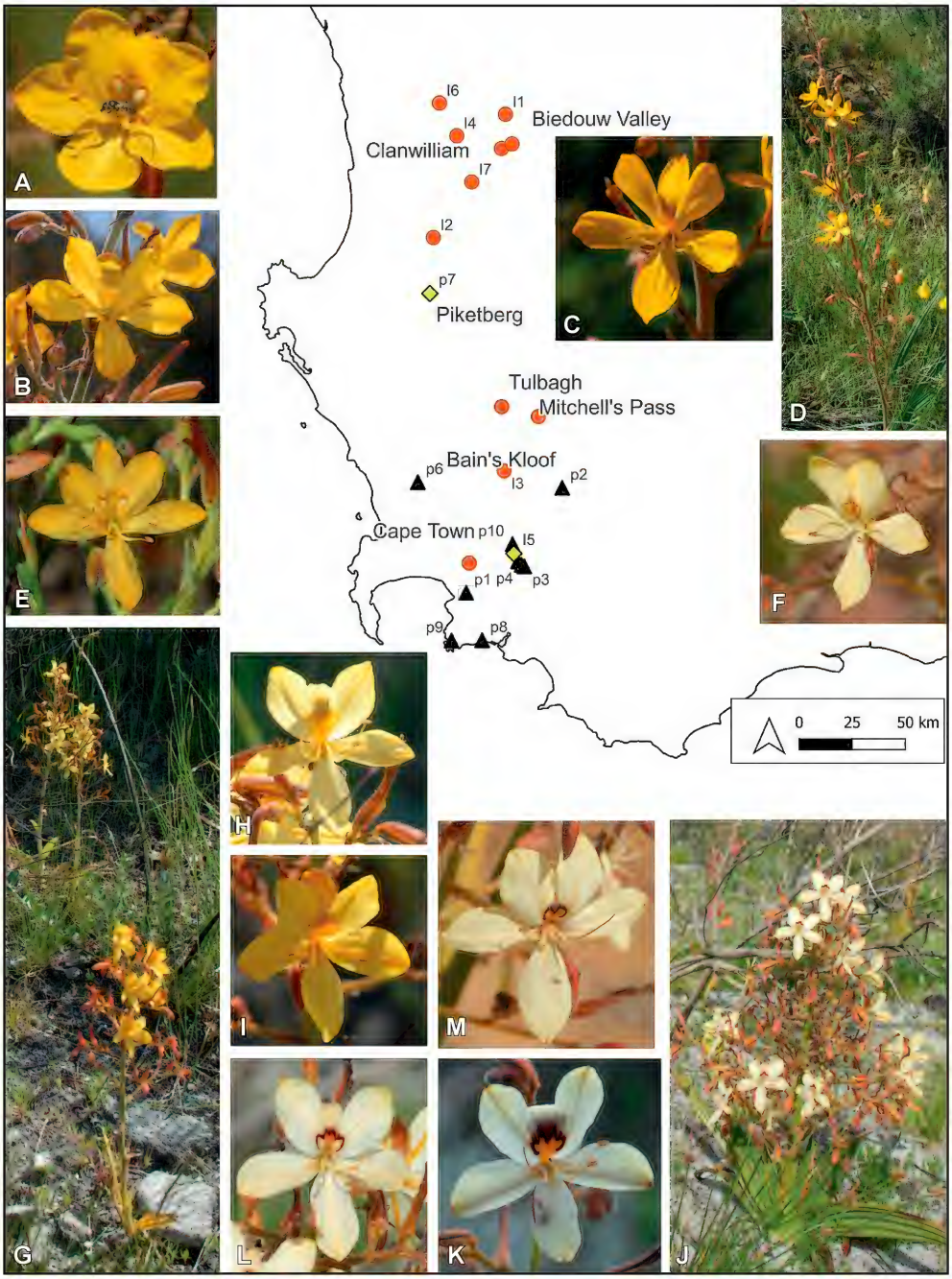

Figure 20. Geographical distribution and images of *Wachendorfia laxa* (●) (A, B, C, D, G bottom, I), *W. paniculata* (▲) (K, L, M, J), and introgressed *W. paniculata* (◇) (E, F, G top, H) along a north south transect undertaken by SDH east of Cape Town from Kleinmond northwards to Clanwilliam in South Africa. Numbered symbols prefaced with l (= *laxa*) and p (= *paniculata*) are sight records (see Table 1) whereas unnumbered *W. laxa* symbols are from herbarium specimen localities at NBG. Note that *W. paniculata* extends further east and west than indicated on the map. Photographs by S.D. Hopper.

Affinities and notes. Molecular analysis shows a very close sister relationship between *W. laxa* and *W. paniculata* (Hopper *et al.* unpubl.). It has taken careful field studies to determine the distinguishing features of these two taxa. *Wachendorfia laxa* differs from *W. paniculata* (Figure 20) in its taller scapes, its bright green, narrow, glossy, almost glabrous leaves that are sometimes scarcely pleated, and its golden flowers with nectar guides that are pale yellow, rimmed by darker gold to yellow-brown colouration (much darker rims in *W. paniculata*, Figure 20). In some populations where the two species are intermixed it is clear that natural hybridization and introgression are occurring (Figure 20). These populations would repay careful genetic and reproductive biological study. We are not perturbed by these occasions where reproductive isolation appears to break down. Other well accepted species of Haemodoraceae display similar interactions, especially in subfamily Conostylidoideae (e.g. Hopper 1977a, 1977b, 1978b, 1993). In the main, however, just as in *W. laxa* and *W. paniculata*, populations remain pure and distinctive.

Wachendorfia laxa, with its bright gold flowers on moderately tall scapes and bright glossy green leaves will make an important contribution to horticulture.

Anigozanthos Labill.

Anigozanthos was last revised by Hopper (1987a) and updated in a subsequent book (Hopper 1993) on the basis of morphometric (Figure 21; Hopper & Campbell 1977) and biosystematic data (Hopper 1980). In these treatments, 11 species and several subspecies were recognised, all endemic to the SWAFR. This taxonomy was the framework used in a cladistic morphological study (Anderberg & Eldenaas 1991) and a molecular phylogenetic study (Le Roux *et al.* 2010). The latter study affirmed *Macropidia* as sister to *Anigozanthos*, but found that *Anigozanthos* section *Anigozanthos* was paraphyletic, with *A. onycis* A.S.George and *A. preissii* Endl. embedded within *A.* section *Haplanthesis*. This finding is supported for *A. onycis* but not for *A. preissii* in our forthcoming unpublished work. A few species were included in subsequent molecular phylogenetic studies of the Haemodoraceae as a whole (Hopper *et al.* 1999, 2009; Zuntini *et al.* 2021), but thereafter a comprehensive study with near-complete taxon sampling was undertaken and is in preparation for publication. This has revealed the presence of three undescribed species and one subspecies of *Anigozanthos* meriting elevation, and indicated the need for some adjustment of the infrageneric classification. These are effected here.

Anigozanthos bicolor Endl. × **A. decrescens** (Hopper) Hopper & R.J.Sm.

This hybrid is intermediate between its putative parents (Figure 22, 23), having perianths 48–64 mm long, narrowing from 9.3–17.2 mm atop the ovary when flattened out to 3.3–6.3 mm wide at the narrowest point above the middle and below the anthers. Anthers are 2.7–4.3 mm long. (Figures 22, 23)

Specimens examined. WESTERN AUSTRALIA: Old Crossman River Bridge, Albany Highway, 22 Oct. 1976, *S.D. Hopper* 754 (PERTH 01962043); 0.4 km S of Old Crossman River Bridge on Albany Highway, 2 Nov. 1975, *S.D. Hopper* 779 (PERTH 01207911); 7.7 km W of Albany Highway, towards Marradong, 2 Nov. 1975, *S.D. Hopper* 780 (PERTH 01961861).

Distribution. Confined to an area between Boddington, Marradong Road and Crossman River (Figures 22, 23).

Habitat. In open wandoo–marri woodland on river flats in clay-loam, sometimes with a few plants of *A. manglesii* and rare hybrids with that species, or in remnant wandoo on weed infested road verges.

Affinities and notes. See discussion below under *Anigozanthos decrescens*.

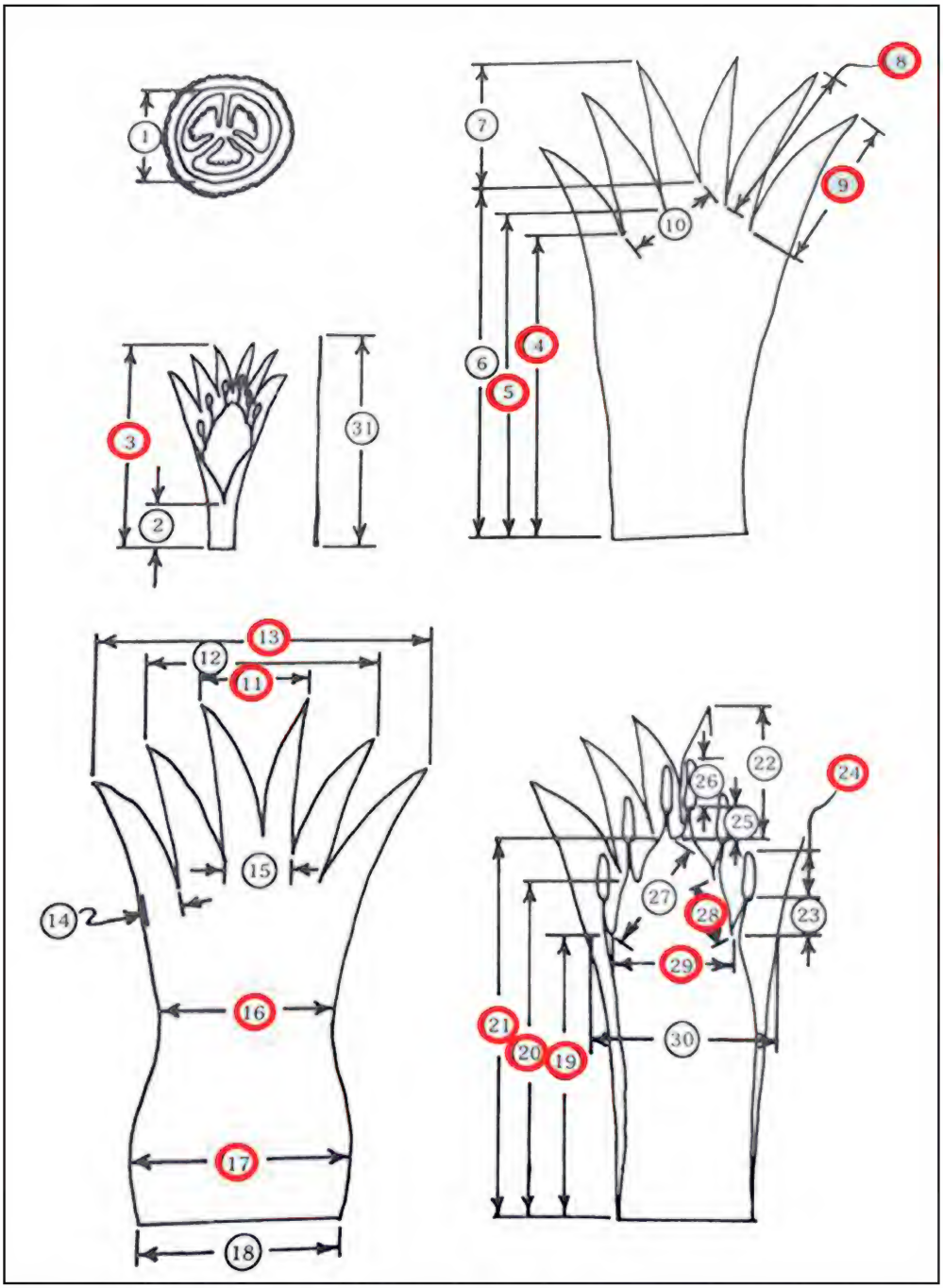

Figure 21. Thirty-one floral measurements used in an initial multivariate morphometrics study (canonical variate analysis) of six populations of *Anigozanthos bicolor*, *A. decrescens* and hybrids (first canonical variate scores of one flower per plant and map in Figure 22 and then 15 characters (red circles) used in a study across 37 populations of both species and their narrow hybrid zone (Figure 23). Illustration by S.D. Hopper.

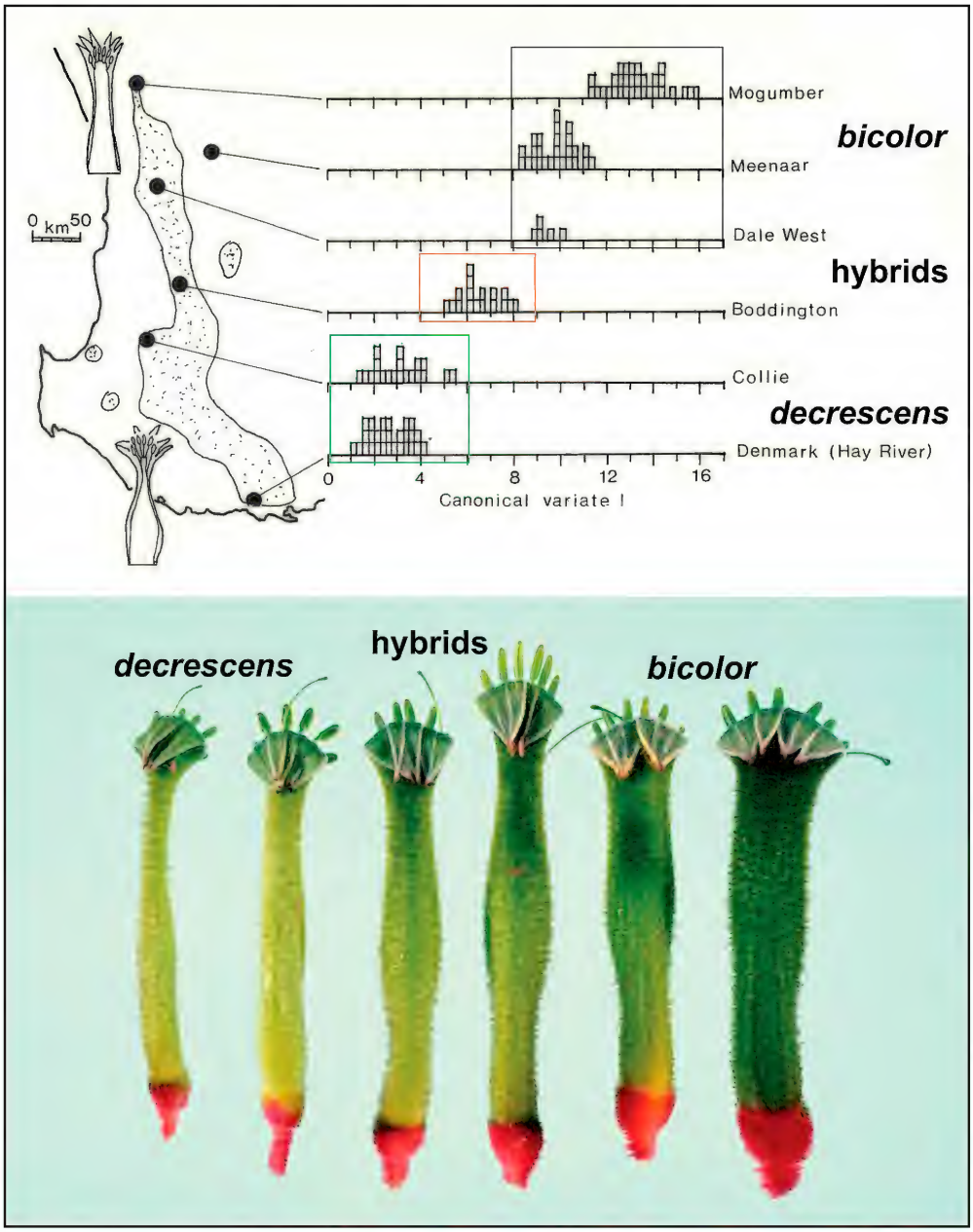

Figure 22. Top map illustrates first canonical variate scores of one flower per plant in an analysis of 31 floral characters (Figure 21) that first established the location of the narrow hybrid zone at Boddington involving *Anigozanthos bicolor* to the north and *A. decrescens* to the south. Below is a photo of flowers from six plants grown in an experimental garden at The University of Western Australia, Perth campus, of *A. decrescens* (two at left, synthesized F_1 hybrids (middle two) and *A. bicolor* subsp. *bicolor* (right two) illustrating inherited differences in perianth shape and ovary colouration. Photograph, illustrations and maps by S.D. Hopper.

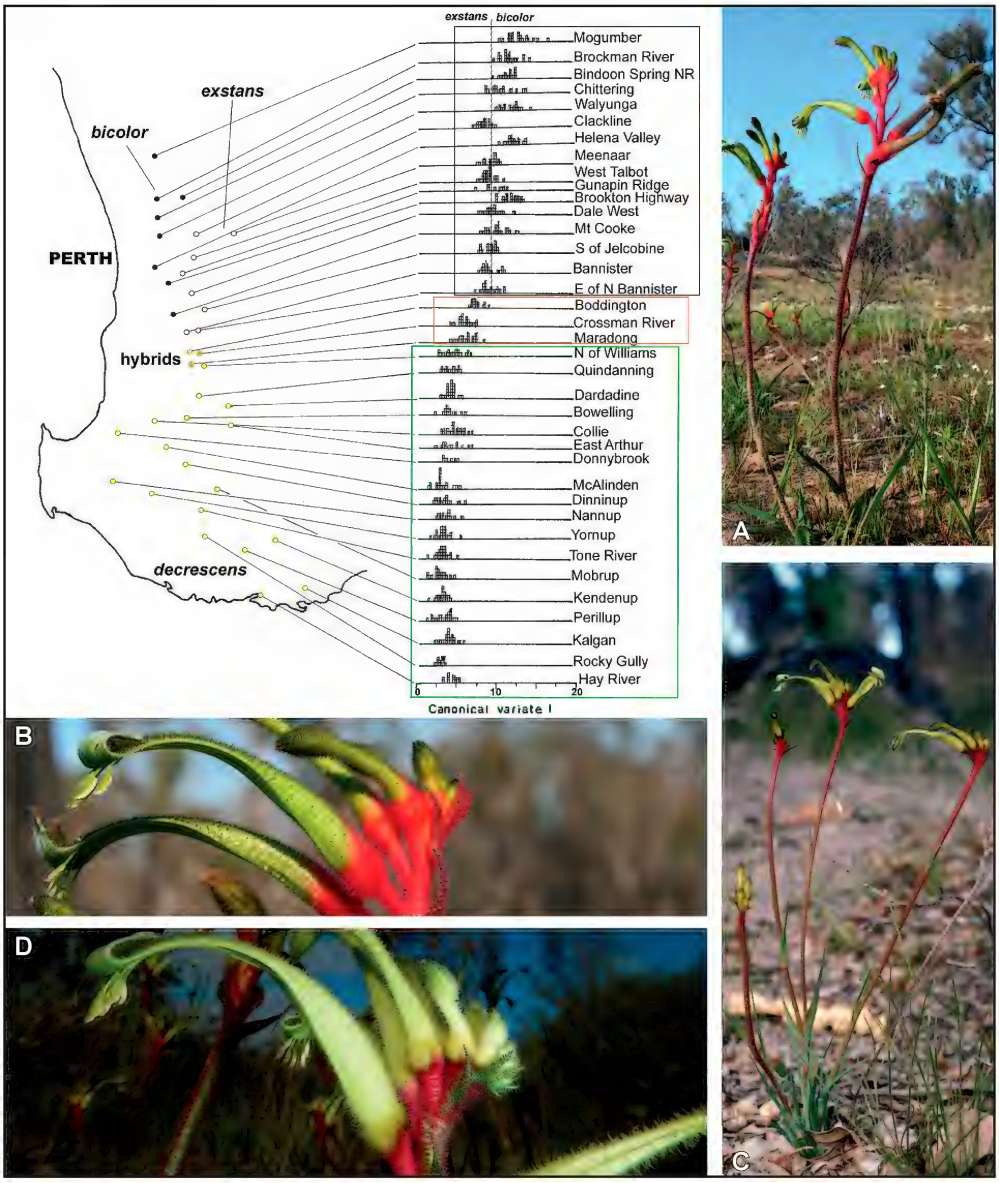

Figure 23. Multivariate morphometrics (canonical variate analysis) of 15 best discriminatory floral characters (Figure 21 red circles) for *Anigozanthos decrescens* and *A. bicolor* from the northern jarrah and wandoo forests and southern jarrah forest of southwest Australia respectively. The study spanned 37 populations of both species and their narrow hybrid zone (*A. bicolor* – black box, ● (subsp. *bicolor*), ○ (subsp. *exstans*); hybrids – orange box, ●; *A. decrescens* – green box, ●). Photographs: *A. bicolor* subsp. *bicolor* A – whole scape; B – flower. *A. decrescens* C – scape; D – flower. Photographs and map by S.D. Hopper.

Anigozanthos condingupensis Hopper & R.J.Sm., *sp. nov.*

Type: Condingup, Fisheries Road, Western Australia [precise locality withheld for conservation reasons], 7 September 1982, *S.D. Hopper* 2510 (*holo*: PERTH 00993239).

Anigozanthos bicolor Endl. var. *minor* Benth., *Fl. Austral.* 6: 446 (1873), *Anigozanthos bicolor* subsp. *minor* (Benth.) Hopper., *Fl. Austral.* 45: 455 (1987) *p.p.*, not as to type.

Illustrations. S.D. Hopper, *Kangaroo paws and catspaws*, pp. 128–129 (1993), as *A. bicolor* subsp. *minor* (Benth.) Hopper.

Small red and green rhizomatous *geophyte* to 45 cm diameter and 15 cm tall. *Roots* sand-binding. *Leaves* 3.2–12 cm long, 0.5–2.5 mm wide. *Scapes* 7–21 cm long. *Perianth* pale green, 30–40 mm long, lobes 4.5–6.0 mm long. *Anthers* 1.0–2.5 mm long; *filaments* to 2.5 mm long. *Style* 3.5–4.5 cm long. *Ovary* pale green for the upper quarter to three quarters of its height, red below. (Figures 24, 25)

Diagnostic features. Distinguished by its short stature (to 15 cm tall), narrow leaves (0.5–2.5 mm wide), small flowers (perianth 30–40 mm long) and the ovary pale green for a quarter to three quarters of its upper height, red below.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 Oct. 2004, *R. Butler* RHB 108 (PERTH 07028059); 29 Oct. 2013, *R. Daniel* RD FlOp-35 (PERTH 09061584); 12 Sep. 2013, *W. Gill, A. Hoggart & T. Gill* 1/913 (PERTH 08796777); 12 Oct. 1983, *K. Newbey* 9756 (PERTH 03517217); 7 Oct. 1963, *J.D. Skoss s.n.* (PERTH 00993204);14 Oct. 2008, *N. Swarts per R.J. Smith* RJS 207 (PERTH 08981523); 7 Aug. 2013, *J. Waters & W. Gill* 3/813 (PERTH 08796572).

Phenology. Flowers August–October.

Distribution. *Anigozanthos condingupensis* ranges from near Mt Baring west to near Lake Shaster (Figure 25).

Habitat. Grows associated with granite outcrops in waterlogged habitat in winter in *Dodonaea ceratocarpa*, *Acacia triptycha* and *Thryptomene australis* shrubland over herbs and grasses such as *Trachymene pilosa*, *Hypochaeris glabra* and *Aira cupaniana*. Other communities include open *Nuytsia floribunda* woodland over open granite heath with *Thryptomene saxicola*, *Acacia acuminata*, *Calothamnus quadrifidus*, *Melaleuca fulgens*, *Borya constricta*, *Tricoryne elatior* and *Labichea lanceolata*. Another is low shrubland over granite with *Verticordia minutiflora*, *Gonocarpus nodulosus*, *Drosera macrantha*, *Anarthria polyphylla*, *Nuytsia floribunda*, *Borya constricta*, *Chamaescilla corymbosa*, *Astus tetragonus* and *Lechenaultia formosa*.

Etymology. The specific epithet is derived from the name of the granite hill and adjacent village of Condingup, east of Esperance. Condingup is a Noongar word, which can be alternatively spelt as Korntdinup, meaning camp or place of shelters (kornt).

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). *Anigozanthos condingupensis* is a relatively rare local endemic with a few populations known from conservation reserves but most on private land or road verges. Further survey to ascertain conservation status is recommended. A threatened status may be warranted, based on observations of the late Alan Carmichael (pers. comm., 30 September 1987) that the species may have disappeared from lands cleared for agriculture, such as the property at the north-east corner of Springdale Road and Masons Bay Road. Similar observations pertain even more so to *A. knappiorum* Hopper (see below), which Mr Carmichael had observed at four locations subject to clearing burns and now cropped.

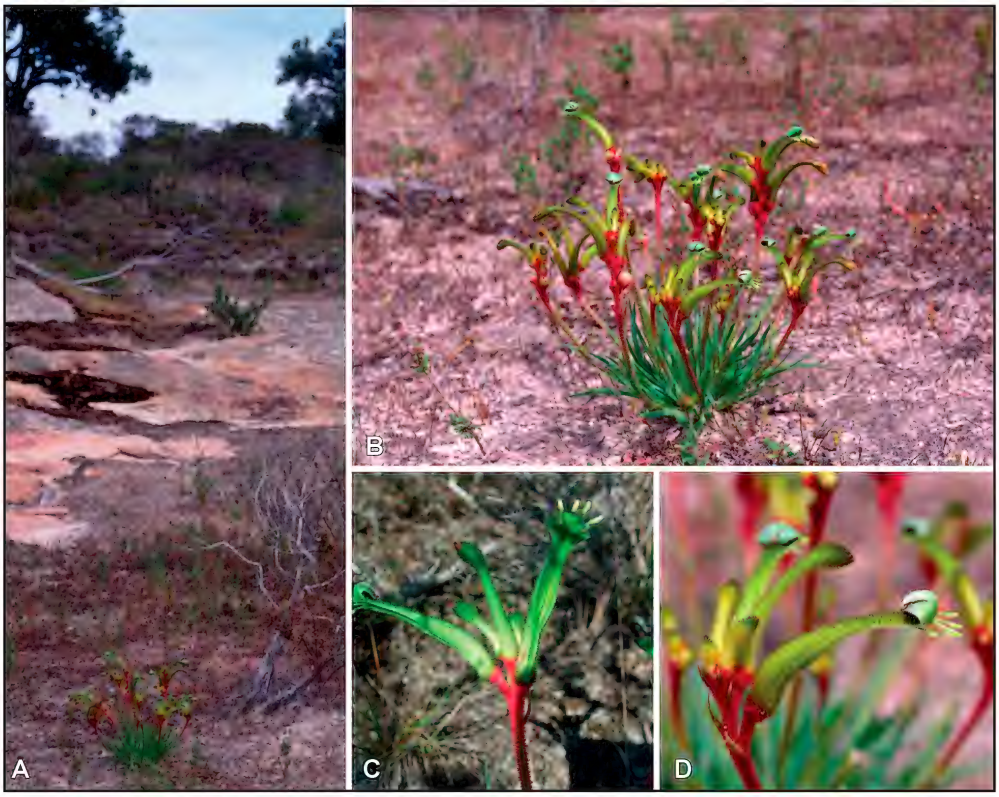

Figure 24. *Anigozanthos condingupensis*. A – plant adjacent granite outcrop, post-fire, at Condingup Peak; B – enlargement of same plant; C – inflorescence at Condingup Peak; D – inflorescence on same plant. Photographs by A.P. Brown (A–C); R.J. Smith (D).

Vernacular name. Condingup Dwarf Kangaroo Paw is recommended.

Affinities and notes. A diminutive red and green kangaroo paw endemic to granite outcrops of the eastern south coast region (Esperance Botanical District) of Western Australia. For a long time, this species was regarded as a cryptic easterly variant of *A. bicolor* subsp. *minor* (here regarded as meriting species rank as *A. knappiorum*), from which it differs in its ovary pale green for the upper quarter to three quarters of its height, red below. There are also subtle differences in the size and shape of the perianth. However, recent DNA studies have revealed that *A. condingupensis* is, in fact, sister to *A. decrescens*, not to *A. bicolor*. Red and green colouration has evolved independently in *Anigozanthos* at least twice. *Anigozanthos decrescens* is like *A. condingupensis* in having its ovary pale green for the upper quarter to three quarters of its height, red below. *Anigozanthos condingupensis* is much smaller in stature and leaf size, and also differs from *A. decrescens* in its special habitat of winter-wet margins associated with granite outcrops.

Bentham's (1873) reference to a G. Maxwell specimen at Kew collected at Stokes Inlet is likely to be *A. condingupensis* because a recent 2004 collection by *R. Butler* (RHB 108, PERTH 07028059) came from west of Stokes Inlet. Geerinck (1970) chose the Maxwell, Culham Inlet (as Mount Callum, *sic*) specimen at Kew as the holotype of *A. bicolor* var. *minor*, which we take to be a lectotypification for that taxon. *Anigozanthos bicolor* var. *minor* is cited below as a synonym for *A. knappiorum*.

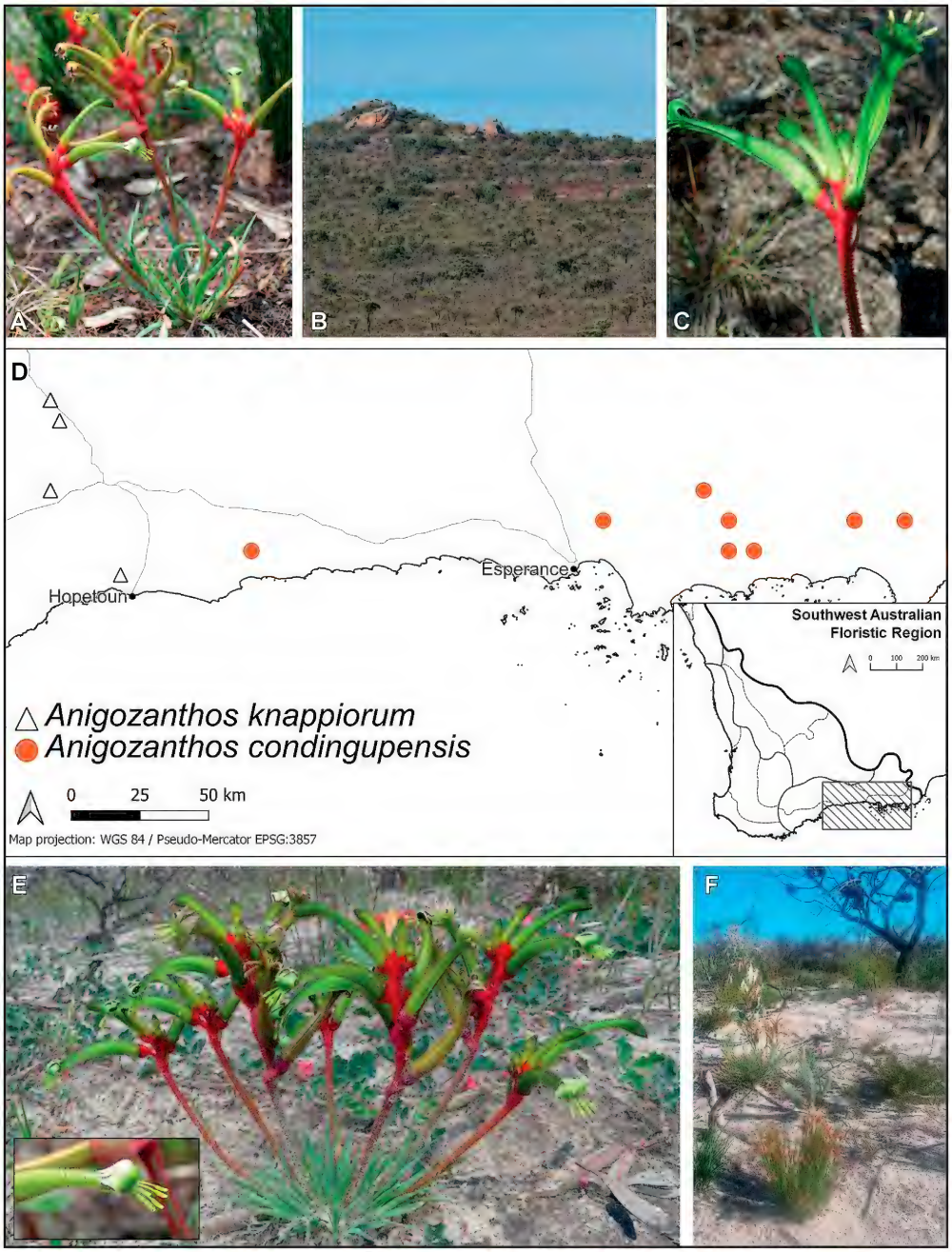

Figure 25. *Anigozanthos condingupensis*. A – habit; B – Condingup Peak viewed from the north, type location; C – flowers; D – distribution (●) mainly in the Esperance Botanical District (Gioia & Hopper 2017), and of *A. knappiorum* (△) in the Maalak Botanical District. Base map modified from Florabase. Inset map of the Southwest Australian Floristic Region shows location in relation to Botanical Provinces and Districts recognized by Gioia and Hopper (2017) – see Figure 1. *Anigozanthos knappiorum*. E – whole plant, west of Ravensthorpe, inset showing outer stamens held beneath the central four; F – sandplain habitat high in the landscape one year after wildfire with killed *Banksia media* plant prominent. Photographs by S.D. Hopper (A, B, D); R.J. Smith (C).

Anigozanthos decrescens (Hopper) Hopper & R.J.Sm., *comb. et stat. nov.*

Basionym: *Anigozanthos bicolor* Endl. subsp. *decrescens* Hopper, *Fl. Australia* 45: 455 (1987b). *Type*: 7 km south of Yornup, Western Australia, 13 November 1975, *S.D. Hopper* 773 (*holo*: PERTH 01224182).

Anigozanthos bicolor southern race, S.D. Hopper & N.A. Campbell, *Aust. J. Bot.* 25: 523–544 (1977); S.D. Hopper, *Aust. J. Bot.* 28: 659–680 (1980).

Illustrations. S.D. Hopper, *Kangaroo paws and catspaws*, pp. 126– 127 (1993), as *A. bicolor* subsp. *decrescens*.

Perennial herbaceous red and green rhizomatous *geophyte*. *Leaves* flat, 10–25 cm long, 2–5 mm wide, grey-green. *Scapes* several, 10–45 cm tall, slightly curved, red-purple with sparse plumose hairs becoming more dense near inflorescence and extending over a quarter of the lower ovary surface. *Floral hairs* uniformly yellow-green, covering upper three quarters of the ovary surface as well as the main perianth, the red and green colours usually separated by a blackish line atop the red-purple of the scape and lower ovary. *Perianth* falcate, 45–65 mm long, strongly constricted in upper part of tube, 3–5 mm wide at narrowest point above middle; lobes reflexed. *Stamens* biseriate, the outer pair lower than other 4; anthers 2.5–4.9 mm long; outer filaments 4.0–7.5 mm long. (Figures 22, 23)

Diagnostic features. Red and green geophyte. Leaves flat, grey-green. Scapes 10–45 cm tall, red-purple with sparse plumose hairs becoming more dense near inflorescence and extending over a quarter of the lower ovary surface. Floral hairs uniformly yellow-green, covering upper three quarters of the ovary surface as well as the main perianth, the red and green colours usually separated by a blackish line atop the red-purple of the scape and lower ovary. Perianth falcate, 45–65 mm long, strongly constricted, 3–5 mm wide at narrowest point above middle. Stamens biseriate, outer filaments 4.0–7.5 mm long.

Other specimens examined. WESTERN AUSTRALIA: Kalgan Plain, Sep. 1946, *A.M. Ashby* 87 (PERTH 01962019); W of Rocky Gully, 34° 30′ 41.0″ S 117° 0′ 42.0″ E, 14 Oct. 1966, *A.M. Ashby* 2023 (PERTH 01961942); Hall site, Muir Highway, Perillup, W of Mount Barker, 18 Nov. 1990, *E.J. Croxford* 6325 (PERTH 04501144); E of Denmark: 4.0 km E of Hay River towards Albany, 30 Oct. 1974, *S.D. Hopper* 805 (PERTH 01961896); *c.* 20 km N of Williams along Albany Highway, 2 Nov. 1975, *S.D. Hopper* 738 (PERTH 01961969); 3.1 km S of Donnybrook towards Kirup, 14 Nov. 1975, *S.D. Hopper* 772 (PERTH 01207946); 4 km S of Blackwood River, Nannup towards Pemberton, 13 Nov. 1975, *S.D. Hopper* 775 (PERTH 01961985); Bow River, Dec. 1912, *S.W. Jackson s.n.* (NSW); 3 km NW of western end Mount Manypeaks, Waychinicup N [National] Park, 23 Oct. 1986, *G.J. Keighery* 8500 (PERTH 01961829); Kodjinup Nature Reserve, NE corner, 21 Oct. 1997, *G.J. Keighery & N. Gibson* 2188 (PERTH 05249546); approximately 100 m N of Golf Club turnoff, S of Mt Barker township, 10 Oct. 1988, *T.D. Macfarlane* TDM 1807 (PERTH 04768523); SWATT Sandplain Survey, Mt Roe National Park, survey site SWA0103C, *c.* 43.12 km W (275.18 degrees) of Mt Barker and *c.* 19.06 km ESE (118.85 degrees) of Rocky Gully, 2 Nov. 2013, *R. Meissner* 5080, *C. McCormack* & *M. Langley* (PERTH 08916276); King Georges Sound, *s.dat.*, *T.R. Muir s.n.* (MEL, labelled in F. von Mueller's hand *Anigozanthos bicolor* Endl. var *longior*); 12 miles E of Twin Peaks, 8 Nov. 1964, *K.R. Newbey* 1641 (PERTH 01961993); Balingup, Dec. 2017, *R.H. Pulleine s.n.* (NSW); Bridgetown, 25 Sept. 1948, *R.D. Royce* 2702 (PERTH 01962000); W of Nornalup, 5 Oct. 1963, *R.D. Royce* 8113 (PERTH 01961950); 12 miles [19.3 km] along Lower King Road, from Emu Point Road, 16 Sep. 1966, *E.M. Scrymgeour* 1115 (PERTH 01961853); Kendenup, Kendenup railway siding adjacent to Carbarup Rd, 22 Aug. 2009, *R.J. Smith* RJS 283 *& S.D. Hopper* (K, PERTH 08813167).

Phenology. Flowers September–November.

Distribution. *Anigozanthos decrescens* has an L-shaped distribution, ranging from north of Williams on the Albany Highway southwest to Donnybrook and Nannup, then south-east to the Hay River east of

Denmark and across to the northwest side of Mt Manypeaks (Figures 22, 23).

Habitat. In winter wet flats, gentle slopes and adjacent to drainage lines of the southern jarrah forest in sandy clay loams. Associated vegetation includes woodland of *Corymbia calophylla*, *Eucalyptus marginata* subsp. *marginata* or *Melaleuca preissiana* over open shrubland of *Xanthorrhoea preissii* over open shrubland, rushland and fernland of *Hypocalymma balbakiae*, *Pericalymma ellipticum* var. *ellipticum, Melaleuca thymoides*, *Taxandria parviceps*, *Lyginia barbata*, *Styphelia pallida* and *Lindsaea linearis*. Other communities include heath to sedgeland with associated vegetation of *Xanthorrhoea preissii*, *Dasypogon bromeliifolius* and *Hakea ceratophylla*, woodland of *Banksia littoralis* and *Melaleuca preissiana* with *Hibbertia stellaris*, *Lepidosperma angustatum*, *Acacia saligna*, or in *Melaleuca cuticularis* open low woodland over regenerating sedges and *Anigozanthos flavidus*. *Anigozanthos decrescens* is common following summer wildfire or roadside disturbances.

Etymology. Named from the Latin *decrescens* (narrowing), alluding to the pronounced constriction of the perianth above the middle before widening again apically to present the anthers and perianth lobes (Figure 22).

Conservation status. *Anigozanthos decrescens* is common and relatively widespread, sometimes occurring in large populations following fire or other disturbances. It occurs in several conservation reserves. Not under threat.

Vernacular name. Forest Kangaroo Paw.

Affinities and notes. Recognition of *A. decrescens* at some rank dates back to earlier than 1896 when Ferdinand von Mueller wrote a manuscript name (*Anigozanthos bicolor* Endl. var. *longior* F. Muell., *ined.*) on an undated specimen at MEL (MEL2268868A, MEL2268877A) collected at King Georges Sound by T(homas) R. Muir. However, it was not until SDH's PhD research in the 1970s that *A. decrescens* was again recognised informally as '*Anigozanthos bicolor* southern race' (Hopper & Campbell 1977; Hopper 1980), thereafter published in 1987 in the *Flora of Australia* as *A. bicolor* Endl. subsp. *decrescens* Hopper (Hopper 1987b) and illustrated in colour under this name subsequently (Hopper 1993).

Our investigations of molecular phylogenetics (Hopper *et al.* unpublished) have established that the affinities of this taxon are not with *A. bicolor*. Rather, the sister to *A. decrescens* may be *A. condingupensis*. These latter two taxa share the extension of the green perianth colouration well down over the ovary, usually terminating at a blackish line that tops the red-purple colouration of the scape. Also there is a markedly constricted perianth, and differences in floral and scape size, with *A. decrescens* being the larger of these two taxa.

A zone of apparent hybridization was discovered between *A. bicolor* (subsp. *exstans* Hopper) and *A. decrescens* in the Crossman River/Boddington/Maradong area (Hopper & Campbell 1977 – in that publication *A. decrescens* was referred to as *A. bicolor* southern race). A future publication investigating this apparent hybridization was foreshadowed. An intensive sampling regime for a morphometric study was subsequently undertaken, but not published until now, to secure a freshly opened flower from up to 30 plants from 37 populations across the ranges of *A. decrescens* and *A. bicolor* (Figures 22, 23).

Firstly, the six populations across this range sampled by Hopper and Campbell (1977; Figure 22) were subject on their own to Canonical Variate analysis (Discriminant Function Analysis) of 31 floral metrics to better understand variation across these two taxa (Figure 21). The first canonical variate of this analysis accounted for 75% of the total separation achieved, and provided complete separation between *A. bicolor* (Mogumber, Meenaar, Dale West) and *A. decrescens* (Collie, Denmark) populations. The central population (Boddington) was assigned predominantly intermediate canonical variate scores which slightly overlapped at either extreme end with those of both the Collie population of *A. decrescens* and the Meenaar population of *A. bicolor* subsp. *exstans*. Character coefficients (Table 2) indicated that

Table 2. Results of the canonical variate analysis of five *Anigozanthos bicolor* and *A. decrescens* populations measured for 31 perianth characters, numbered in the same sequence as those in Figure 21. *weighted by multiplying the character coefficient by the within-groups standard deviation.

Character	**Canonical Variate 1**		**Canonical Variate 2**	
	Coef.	Wtd Coef.*	Coef.	Wtd Coef.*
1 Ovary diameter	.36	.19	-.16	-.09
2 Perianth closure length	-.23	-.26	.05	.06
3 Perianth length	.29	1.08	-.39	-1.47
4 Base – outer sinus	-.11	-.35	.43	1.42
5 Base – second sinus	.09	.37	-.05	-.16
6 Base – central sinus	-.02	-.07	-.28	-.93
7 Central sinus depth	.12	.14	.34	.40
8 Second sinus depth	-.38	-.42	.19	.21
9 Outer sinus depth	.40	.43	.22	.24
10 Central – outer sinus	-.52	-.29	.15	.09
11 Central lobe tips width	.24	.41	-.12	-.21
12 Second lobe tips width	.03	.05	-.04	-.07
13 Outer lobe tips width	-.48	-1.03	.04	.09
14 Outer lobe basal width of central lobes	-.11	-.04	.16	.06
15 Basal width of central lobes	-.67	-.38	-.36	-.20
16 Minimum upper perianth width	1.55	.92	2.00	1.19
17 Maximum lower perianth width	-.44	-.79	.13	.23
18 Basal perianth width	-.10	-.18	-.35	-.63
19 Base – outer filament	-.04	-.13	-.37	-1.16
20 Base – second filament	-.24	-.76	.16	.50
21 Base – central filament	.13	.40	.28	.89
22 Apex – central filament	-.13	-.14	.00	.00
23 Outer filament length	-.12	-.08	-.87	-.60
24 Outer anther length	1.70	.65	-.08	-.03
25 Central filament length	.19	.12	.98	.62
26 Central anther length	-1.00	-.41	.27	.11
27 Outer – central filaments	.20	.15	-.55	-.39
28 Outer – second filaments	-.65	-.44	1.06	.72
29 Width across outer filaments	1.27	.75	-1.77	-1.05
30 Perianth width at outer filaments	.09	.09	.61	.62
31 Style length	.08	.38	.14	.65
Canonical root	17.09		3.07	
Wilk's lambda	.002		.031	
% of total separation	75.1%		13.5%	

perianth length, width across the outer perianth lobes, minimum upper and maximum lower perianth widths, distance between the outer filaments, a contrast in distances from the perianth base to the second and central filaments, and anther length were all important discriminatory characters. Examination of perianth tracings (Figure 22) and photographs of flowers (Figure 22, 23) confirmed that *A. bicolor* from Mogumber, Meenaar and Dale West has perianths that are relatively broad in the area of constriction (4.6–9 mm), and longer anthers (3.2–5.0 mm). In addition, the outer filaments are about the same length as the anthers and are not displaced far down the perianth from the central four. In contrast, *A. decrescens* from Collie and Denmark has perianths that are narrower in the area of constriction (2.8–5.2 mm). It has outer filaments that are much longer than the anthers and are displaced a relatively large distance down the perianth from the central four. Anthers are shorter (2.7–4.5 mm). The two taxa also differ in the colour of their ovaries (red-purple, sometimes topped with a blackish line, and then yellow-green above in *A. decrescens*, red in *A. bicolor*; cf. Figure 23). The Boddington population (Figure 22) and synthesised inter-specific F_1 hybrids (Figure 22) are intermediate in these parameters.

After successive elimination of characters that showed little or no discrimination between *A. decrescens* and *A. bicolor*, the first canonical variate of an analysis of the remaining 15 perianth characters (red circles in Figure 21) measured on 39 populations of *A. bicolor* and *A. decrescens* (Figure 23; Table 3) accounted for 77% of the total separation. As in the 31-character analysis, the 15-character analysis was instrumental in discriminating between most of the 15 populations of *A. bicolor* and the 18 populations of *A. decrescens* analysed. Populations of *A. bicolor* subsp. *exstans* on the eastern margin of *A. bicolor* subsp. *bicolor* (e.g. Meenaar, Clackline) showed a greater similarity to *A. decrescens* than their western congeners. Overall, *A. bicolor* displayed greater between-population variation in canonical variate scores than did *A. decrescens*, consistent with recognition of two subspecies in *A. bicolor* in the study area.

A suite of three central populations (Boddington, Crossman River, Maradong) were morphometrically intermediate between *A. bicolor* subsp. *exstans* and *A. decrescens*. *Anigozanthos bicolor* extended over a 200 km range, *A. decrescens* extended 250 km, while the zone of intergradation was no wider than 25 km. Character coefficients (Table 3) indicated that perianth length, contrasts in distances from the perianth base to the second and central filaments, and contrasts in widths of minimum upper, maximum lower and outer perianth lobe tips were important discriminators (see red circles in Figure 21).

The second canonical variate accounted for only 7% of the total separation achieved, and discriminated between populations in an apparently random geographical fashion. The Meenaar population (*A. bicolor* subsp. *exstans*) was given a considerably higher mean canonical score than any other population for this variate, while the Brockman River population (*A. bicolor* subsp. *bicolor*) was given the lowest. Other high scoring populations included Boddington (zone of intergradation), Mogumber (*A. bicolor* subsp. *bicolor*) and Collie (*A. decrescens*), while other low scoring populations included Chittering Valley (*A. bicolor* subsp. *bicolor*), Mount Cooke (intermediate between *A. bicolor* subsp. *bicolor* and *A. bicolor* subsp. *exstans*) and Nannup (*A. decrescens*). Character coefficients (Table 3) were weighted in a similar fashion to those of the first canonical variate, suggesting that the Meenaar population differed from most others in the relative positions of its filaments in perianths and in relative perianth widths.

The identification of the Crossman River/Boddington/Maradong area as a localised zone of hybridization between *A. bicolor* and *A. decrescens* will enable more rigorous investigation of reproductive interactions between the two species. Some early evidence on seed set and pollen fertility of progeny from experimental hybridization (Hopper 1980) shows that some reductions in reproductive performance may be expected in the wild hybrid zone. However, this will need experimental tests to affirm or falsify. Also next generation phylogeographic studies would be a powerful approach to testing the geographical pattern revealed through multivariate morphometrics.

Perhaps some taxonomists would regard a zone of hybridization like that found here as evidence that varietal/subspecific rather than species rank is more appropriate to use for the two taxa. However, such a treatment would render *A. bicolor* paraphyletic, disguising the true affinities of *A. decrescens* with *A. condingupenesis*. Moreover, the pattern revealed is consistent with that predicted under a classic

Table 3. Results of the canonical variate analysis of 35 *Anigozanthos bicolor* and *A. decrescens* populations measured for 15 perianth characters, numbered in the same sequence as those in Figure 21. *weighted by multiplying the character coefficient by the within-groups standard deviation.

Character	**Canonical Variate 1**		**Canonical Variate 2**	
	Coef.	Wtd Coef.*	Coef.	Wtd Coef.*
3 Perianth length	.16	.62	.13	.48
4 Base – outer sinus	-.00	.00	-.04	-.15
5 Base – second sinus	.00	.03	.06	.21
8 Second sinus depth	.13	.15	.29	.34
9 Outer sinus depth	.12	.15	.23	.28
11 Central lobe tips width	.05	.08	.02	.04
13 Outer lobe tips width	-.37	-.77	-.51	-1.06
16 Minimum upper perianth width	1.29	.72	-1.70	-.95
17 Maximum lower perianth width	-.38	-.60	.26	.41
19 Base – outer filament	-.09	-.27	-.30	-.94
20 Base – second filament	-.28	-.87	-.27	-.84
21 Base – central filament	.27	.86	.55	1.77
24 Outer anther length	.51	.20	-.46	-.18
28 Outer – second filaments	-.33	-.25	-.22	-.17
30 Perianth width at outer filaments	1.20	.58	1.58	.76
Canonical root	12.22		1.14	
Wilk's lambda	.062		.133	
% of total separation	77.3%		7.2%	

biological species concept (Grant 1971). There is no evidence of broadscale introgression over extensive distances occurring in this case. Substantial but not complete reproductive isolation is found in the hybrid zone, and the majority of populations to the north and south have predictable morphometrics consistent with two species interacting only at the relatively narrow zone of contact.

This is a classic case where univariate characters may overlap, but multivariate character combinations deliver consistent distinguishing characteristics of perianth size and shape found in the two taxa. Resolution of species boundaries is sometimes challenging, but still tractable with an appropriate sampling and analytical strategy in place.

Anigozanthos humilis Endl. subsp. **grandis** Hopper, *subsp. nov.*

Type: Minyulo Nature Reserve, north-northeast of Cataby, Western Australia [precise locality withheld for conservation reasons], 12 October 2022, *S.D. Hopper* 8716 (*holo*: PERTH 09723161; *iso*: CANB, K).

Anigozanthos humilis subsp. 'grandis', informal name in S.D. Hopper, *Kangaroo paws and catspaws*, p. 117 (1993).

Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 1 Nov 2022].

Illustrations. S.D. Hopper, *Kangaroo paws and catspaws*, pp 116–117 (1993); K.S. Downes, *Germination Requirements of the Lesser Known Kangaroo Paw and Catspaw Taxa*, p. 9 (2016).

Scapes tall, up to 100 cm long (averaging 52 cm). *Leaves* large, up to 35 cm long (averaging 19.8 cm); the node of one of the larger leaves sometimes producing a second scape. *Flowers* yellow and orange-tipped on perianth segments, with perianths that are slightly curved, about 35 mm long, with lobes slightly reflexed. (Figure 26)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 20 Sep. 1988, *S.D. Hopper* 6730 (PERTH 06076882); 19 Dec. 1988, *S.D. Hopper* 7111 (PERTH 01190598); 22 Oct. 1983, *G.J. Keighery* 6931 (PERTH 01173731); 26 Sep. 1991, *S.J. Patrick* SP 818 & *A.P. Brown* (PERTH 02113716); 26 Sep. 1991, *S.J. Patrick* SP 820 & *A.P. Brown* (PERTH 02113708); 26 Sep. 1991, *S.J. Patrick* SP 828 (PERTH 03146197); 27 Aug. 2009, *R.J. Smith RJS* 286 & *S.D. Hopper* (PERTH 08813027); 31 Oct. 2013, *V. Yeomans & A. Sleep* D2-02 (PERTH 08631735).

Phenology. Flowers late September–November.

Distribution. Confined to an area near Gingin, Cataby and Moora (Figure 27).

Habitat. Grows in rich, sandy clay loam, along creeks and near swamps in kwongkan adjacent to open wandoo woodland (Figure 26D).

Etymology. From the Latin adjective *grandis*, *-e*, large or big.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Anigozanthos humilis* subsp. Badgingarra (S.D. Hopper 7114). Not considered threatened, even though a relatively local endemic and succumbing readily to rust disease.

Vernacular name. Giant Catspaw is recommended.

Affinities and notes. Readily distinguished from the typical subspecies of *A. humilis* (Figure 26B) by its taller stature (*A. humilis* subsp. *humilis* averages 13–18 cm tall) and uniformly yellow flowers, occasionally with the perianth lobes tipped with orange-red (Figure 26E). *Anigozanthos humilis* subsp. *chrysanthus* Hopper is intermediate in stature between these two other subspecies (averaging 32 cm) and consistently yellow with shorter broad flowers. *Anigozanthos humilis* subsp. *grandis* intergrades at its type locality with *A. humilis* subsp. *humilis*, the latter occurring in deeper sand in kwongkan. The two subspecies are ecologically divergent and occur in pure populations away from this narrow zone of intergradation. It seems, on the basis of pollination studies elsewhere (Hopper & Burbidge 1978, 1986; Hopper 1993), that *A. humilis* subsp. *grandis* has evolved to favour perch-feeding by honeyeaters, whereas the considerably shorter *A. humilis* subsp. *humilis* favours pollination through honeyeaters mainly standing on the ground.

Anigozanthos knappiorum Hopper, *sp. nov.*

Type: west of Ravensthorpe, Western Australia [precise locality withheld for conservation reasons], 30 September 1987, *S.D. Hopper* 6154 (*holo*: PERTH 09214283).

Anigozanthos bicolor Endl. var. *minor* Benth., *Fl. Austral.* 6: 446 (1873); *Anigozanthos bicolor* subsp. *minor* (Benth.) Hopper, *Fl. Australia* 45: 455 (1987); *p.p.*, as to type. *Type*: McCallum [Culham] Inlet, Western Australia, 1873, *G. Maxwell s.n.* (*lecto*: K, barcode K000846250, designated by D. Geerinck, *Bull. Jard. Bot. Natl. Belg.* 40: 274 (1970), as *holo*).

Small short-lived rhizomatous red and green *geophyte* to 30 cm diameter and 20 cm tall. *Roots* sand-binding. *Leaves* 3–10 cm long, 1.5–2.5 mm wide. *Scapes* several, 5–20 cm long, straight, erect to obliquely ascending with flowers held facing outwards (vs gently curved with flowers facing inwards to centre of the plant). *Flowers* red and green, top of ovary marks the upper extent of red coloration. *Perianth* in life green, 30–50 mm long, gently curved throughout, when flattened out 30–50 mm long and 7–12 mm

Figure 26. *Anigozanthos humilis* subsp. *grandis*. A – whole plant illustrating tall erect inflorescences, large leaves and kwongkan habitat adjacent to *Eucalyptus wandoo* at type locality; B – whole plant (right) beside two orange-flowered and much shorter *A. humilis* subsp. *humilis* at type locality; C – pure yellow morph showing details of inflorescence; D – kwongkan habitat adjacent to wandoo woodland lining Minyulo Creek at type locality; E – morph with red tips to buds and perianth lobes; F – rhizome and roots, which are not sand-binding. Photographs by S.D. Hopper.

wide at base, 3–5 mm wide at narrowest point, basal third parallel-sided when opened out then strongly constricted at the level of the outer stamens; *style* 30–40 mm long; outer *anthers* tucked under the four central anthers with outer anther apices reaching only to half way along the four central anthers; outer *filament* length 4–5 mm long. (Figure 25)

Diagnostic features. Small short-lived rhizomatous geophyte to 30 cm diameter and 20 cm tall. Scapes several, 5–20 cm long, straight, erect to obliquely ascending with flowers held facing outwards. Perianth when flattened out 30–50 mm long and 3–5 mm wide at narrowest point, conspicuously constricted below the stamens. Top of ovary marks the upper extent of red coloration. Outer anthers tucked under the four central anthers with outer anther apices reaching only to halfway along the four central anthers.

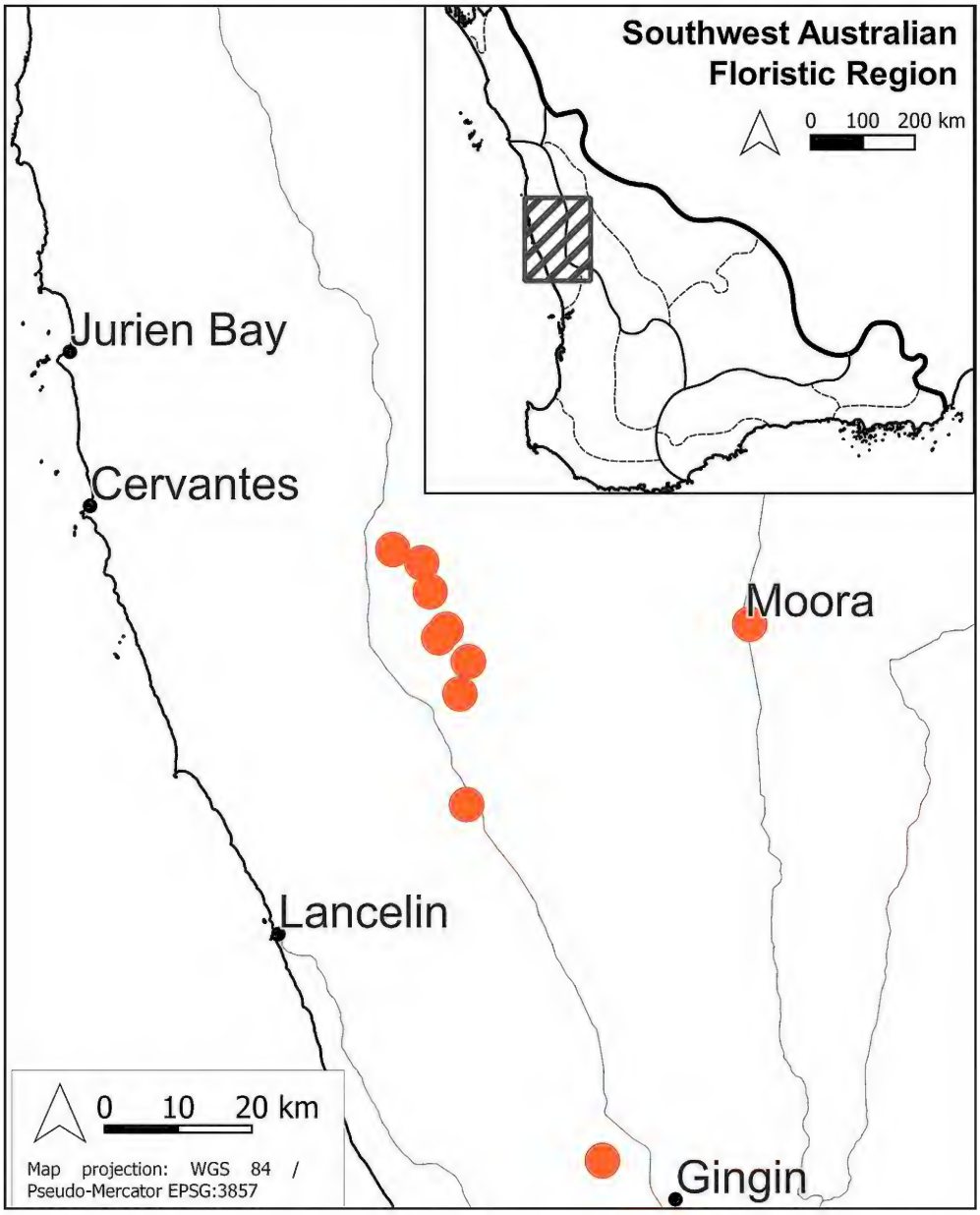

Figure 27. Geographical distribution of *Anigozanthos humilis* subsp. *grandis* (●) based on specimen data from the Atlas of Living Australia. Inset map of the Southwest Australian Floristic Region showing Provinces and Districts as in Gioia and Hopper (2017) – see Figure 1.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 Sep. 2006, *M. Bennett* 1076 (PERTH 07518099); 8 Dec. 2006, *J.A. Cochrane* JAC 6241 & *T. Erikson* (PERTH 07504144); Nov. 1935, *C.A. Gardner s.n.* (PERTH 00993212, 00993190); 26 Sep. 2006, *T. Nicholls* TN 40, *N. Perkins & A. Coates* (PERTH 08356475).

Phenology. Flowers September–late October, mostly setting seed late December.

Distribution. A microendemic species with a restricted range north and north-west of Ravensthorpe (Figure 25).

Habitat. Occupies high positions in the landscape (OCBILs) in kwongkan dominated by *Eucalyptus pleurocarpa* and *Banksia media*, with other members of Haemodoraceae including *Anigozanthos humilis*, *A. rufus*, *Conostylis seorsiflora* and occasional *Haemodorum spicatum*. Rare hybrids of *A. humilis* × *A. knappiorum* have been seen. The species itself is only seen for one or two years after hot summer wildfire, from which it regenerates only from seed.

Etymology. Named for members of the Merningar Bardok Knapp family who have contributed greatly to recent understanding of caring for country from a cultural perspective along the south coast from Israelite Bay to west of Walpole. Today's Knapps still enjoy continuous oral history passed down particularly by Alf Knapp and his sister Aunty Bonny. Dr Lynette Knapp has played a central role in collaborating with University of Western Australia Albany campus staff, and in recording family oral history (e.g. Knapp 2011; Knapp *et al.* 2024). Her children, especially Dion Knapp and Shandell Cummings, have played an increasing role in recording family history, and Lynette's son Michael is a gifted artist.

Conservation status. Listed as Threatened under State and Federal jurisdictions with a ranking of Vulnerable (State of Western Australia 2025) and Endangered (Department of Climate Change, Energy, the Environment and Water 2025), respectively, under the name *Anigozanthos bicolor* subsp. *minor*. The conservation status of *A. knappiorum* will be reassessed because the current listing incorporates occurrences of what is now recognised as *A. condingupensis*.

Vernacular name. Knapp's Dwarf Kangaroo Paw is recommended.

Affinities and notes. *Anigozanthos knappiorum* has proved to be one of the most elusive species in the genus due to its propensity to flower only after hot wildfire. It has been variously confused with *A. gabrielae* Domin and *A. bicolor*. It is readily distinguished from *A. bicolor* in its smaller flowers which are held facing outwards away from the plant, and the unique way in which the two outer stamens are held beneath the central four and do not extend forward to the same degree. Specifically, *A. knappiorum* differs from *A. bicolor* in its scape straight, erect to obliquely ascending with flowers held facing outwards (vs gently curved with flowers facing inwards to centre of the plant), smaller red and green flowers (measurements below; vs larger, longer flowers); the green perianth in life 30–50 mm long (vs 45–75 mm), gently curved throughout (vs abruptly downcurved approaching the stamens); perianth when flattened out 30–50 mm long and 7–12 mm wide at base, 3–5 mm wide at narrowest point (vs 45–75 mm long and 11–13 mm wide at base, 4–12 mm wide at narrowest point), basal third parallel-sided when opened out then strongly constricted at the level of the outer stamens (vs gently narrowing from the base to the constriction at the outer stamens); style 30–40 mm long (vs 40–75 mm long); top of ovary marks the upper extent of red coloration (same in *A. bicolor*); outer anthers tucked under the four central anthers with outer anther apices reaching only to half way along the four central anthers (vs outer anthers splayed apart from the four central anthers and outer anther apices almost attaining the apices of the four central anthers); outer filament length 4–5 mm long (vs 2–7.5 mm long). The flowers of *A. gabrielae* are even smaller and quite broad relative to length when flattened out compared to the slender constricted flowers of *A. knappiorum*. In addition, the red-purple coloration on *A. gabrielae* extends only part way up the ovary, whereas the bright red colour of *A. knappiorum* extends to the top of the ovary. *Anigozanthos yorlining*, described below, differs in a similar way from *A. knappiorum* to *A. gabrielae*. *Anigozanthos condingupensis* has red-purple coloration extending only part way up the ovary.

See *Affinities and notes* section under *A. condingupensis* for discussion regarding the type of *Anigozanthos bicolor* var. *minor*.

Anigozanthos viridis Endl. subsp. **metallicus** Hopper, *subsp. nov.*

Type: 1.5 km north of Wongonderrah Road, along Yerramulla Road, east of Cervantes, Western Australia, 9 October 2008, *R.J. Smith* RJS 182, *S.D. Hopper & L. Sweedman* (*holo*: PERTH 08804214; *iso*: K).

Anigozanthos viridis Endl. subsp. 'metallica', S.D. Hopper, *Kangaroo paws and catspaws*, pp 134–135 (1993).

Anigozanthos viridis subsp. Cataby (S.D. Hopper 1786), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 22 May 2025].

Illustrations. S.D. Hopper, *Kangaroo paws and catspaws*, pp 134–135 (1993).

Leaves flat, 10–20 cm long. *Scapes* intermediate in height between those of subsp. *viridis* and subsp. *terraspectans* (12–40 cm tall, usually 15–30 cm). Like subsp. *viridis*, the flowers open towards the axis of the plant. *Perianths* almost iridescent green and 50–70 mm long. *Floral hairs* distinctively dark metallic-green. (Figure 28)

Other specimens examined. WESTERN AUSTRALIA: *c.* 400 m S of Wongonderrah Road at *c.* 4 km W of Yerramullah Road, SE of Cervantes, 20 Oct. 2007, *A. Crawford* 1452 (PERTH 08008310); 8 km along Wongonderrah Road from Brand Highway, Badgingarra, 21 Oct. 1978, *J. Dodd s.n.* (PERTH 01205803); SE corner, Moore River National Park (Reserve 28462), NW of Gingin, 17 Oct. 1992, *E.A. Griffin* 7282 (PERTH 03422402); SE corner, Moore River National Park (Reserve 28462), NW of Gingin, 17 Oct. 1992, *E.A. Griffin* 7285 (PERTH 03422364); 12 km W of Gingin – Dongara road on road to Nambung National Park, 29 Nov. 1974, *T.A. Halliday* 165 (PERTH 03911624, AK); Beermullah, 10 km N of Gingin along Jurien Bay road, 7 Oct. 1975, *S.D. Hopper* 26 (PERTH 03911659); *c.* 25 km SE of Cervantes, 16.1 km W of Brand Highway and 2.5 km N of Coowarloo [Cooljarloo] road, 28 Oct. 1976, *S.D. Hopper* 729 (PERTH 03911667); *c.* 15 km SW of Cataby Roadhouse, 9.4 km SW of Brand Highway along Mimegarra road, 28 Oct. 1976, *S.D. Hopper* 748 (PERTH 03911632); 1 km W of Brand Highway along Beermullah West Rd, 6 Nov. 1975, *S.D. Hopper* 814 (PERTH 01205838); 31 km N on Mimegarra road, start 18 km E of Lancelin (*c.* 50 km ENE Lancelin), 17 Oct. 1981, *G.J. Keighery* 4127 (PERTH 03911640); intersection of Wongonderrah and Munbinea Roads, NW corner, 11 Sep. 1991, *S. Patrick* 789 (PERTH 06889549); 61 mile peg Gingin Road [14 km N of Gingin on the Brand Highway], 22 Sep. 1974 *C.I. Stacey* 319 (PERTH 01679317); along Great Northern Highway 1.5 km N of Bullsbrook, 30 Sep. 1982, *A. Strid* 20650 (PERTH 03911675).

Phenology. Flowers August–September. October and November specimens are post-flowering.

Distribution. Occurs between Beermullah and Nambung National Park in the Lesueur Floristic District of Gioia and Hopper (2017) (Figure 29).

Habitat. Favours low heath and sedge in winter-wet flats and swamps.

Etymology. Named from the Latin adjective *metallicus, -a, -um*, metallic, alluding to the almost iridescent green flowers.

Conservation status. Not under threat. Known from a few conservation reserves.

Vernacular name. Metallic Green Kangaroo Paw is recommended.

Affinities and notes. Readily distinguished from *A. viridis* subsp. *viridis* by its shorter stature and metallic green flowers. From *A. viridis* subsp. *sophrosyne* Hopper this subspecies differs in having terete, not flat leaves and shorter stature. Smaller specimens of *A. viridis* subsp. *metallicus* have been confused with

Figure 28. *Anigozanthos viridis* subsp. *metallicus*. A – close-up of inflorescence; B – whole plant highlighting the iridescent green colouration. Photographs by S.D. Hopper.

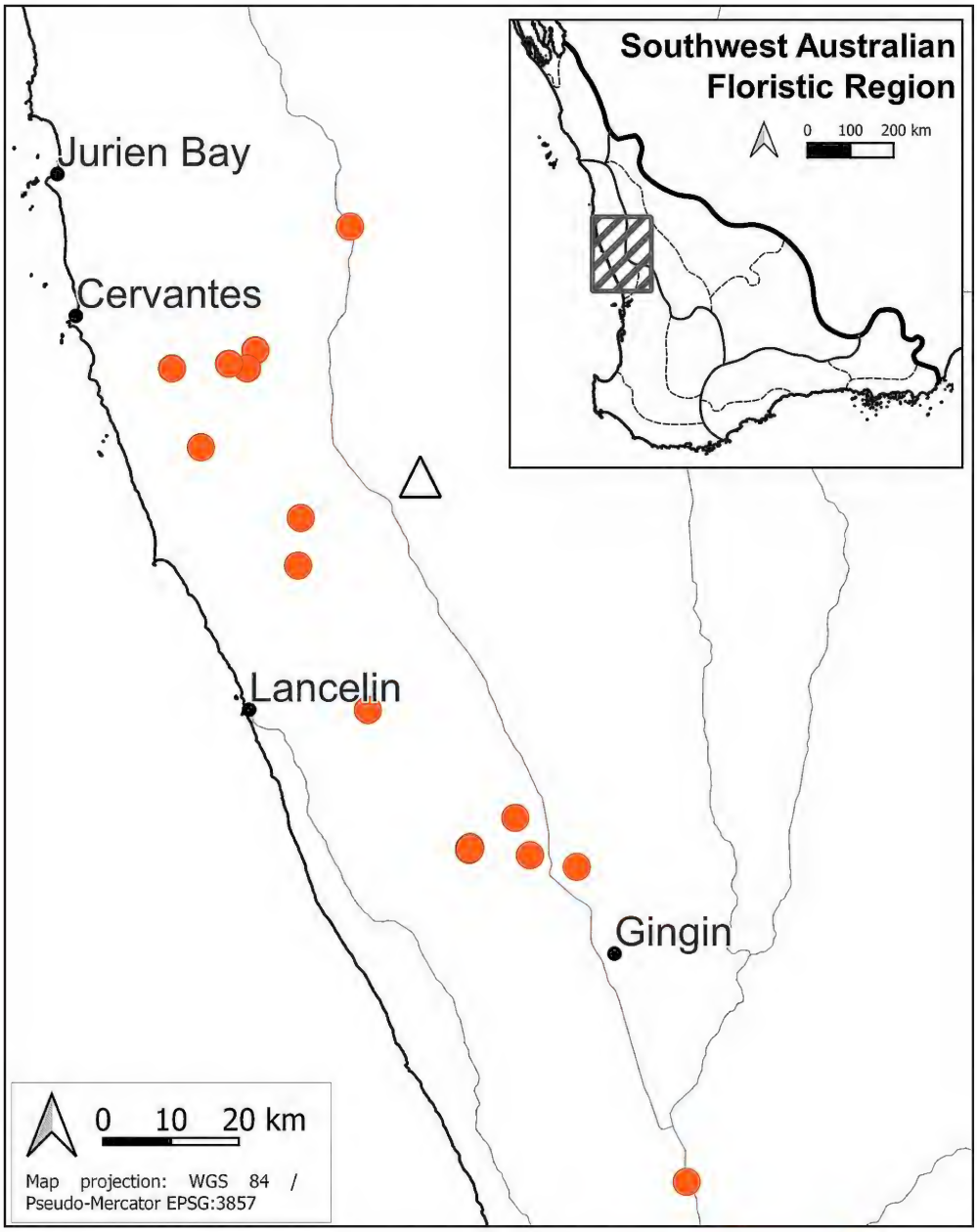

Figure 29. Map showing the geographical distribution of *Anigozanthos viridis* subsp. *metallicus* (●) and *A. viridis* subsp. *sophrosyne* (△) adapted from Florabase. Inset shows location within the Southwest Australian Floristic Region *sensu* Gioia and Hopper (2017) – see Figure 1.

A. viridus subsp. *terrespectans* Hopper, but its flowers overhang the recurved scape rather than being thrust outwards away from the scape.

Anigozanthos viridis Endl. subsp. **sophrosyne** Hopper, *subsp. nov.*

Type: ENE of Cataby roadhouse on Brand Highway, Western Australia [precise locality withheld for conservation reasons], 12 October 2022, *S.D. Hopper* 8717 (*holo*: PERTH 09723145; *iso*: CANB).

Illustrations. K.S. Downes, *Germination Requirements of the Lesser Known Kangaroo Paw and Catspaw Taxa*, p. 12, (2016), as *Anigozanthos manglesii* var. × *angustifolius*.

Leaves flat, 23–30 cm long, 4–9 mm wide. *Scapes* tall, to 40–60 cm; like *A. viridis* subsp. *viridis* and *A. viridis* subsp. *metallicus*, the flowers open towards the axis of the plant. *Perianths* rich green, rarely yellowish, and 50–55 mm long. (Figure 30)

Other specimens examined. None.

Phenology. Flowers late September–October.

Distribution. Confined to a narrowly endemic range east of Cataby.

Habitat. Favours *Eucalyptus rudis* woodland on winter-wet flats, swamps and water courses.

Etymology. Named from the Greek virtue, *sophrosyne*, female, (Σωφροσύνη) which is an ideal of excellence of character and soundness of mind. Many historians wrote about it and Heraclitus stated:

'Sophrosyne is the greatest virtue, and wisdom is speaking and acting the truth, paying heed to the nature of things'.

The epithet celebrates the three female grandchildren of S.D. and C.G. Hopper, Sofia, Ioanna Rose and Melina Eve, the latter two of whom were born as twins on the day SDH collected the type specimens of the new subspecies. It is his fervent wish that they are sophrosynous in their lives, wise, acting the truth and paying heed to the nature of things. Sofia is already on this track. Rosie and Mel will surely follow. Their Australian flower will be there as a symbol of this great virtue.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). Potentially threatened given its narrow geographical range in an extensively cleared landscape. Further field survey is necessary. Also, bringing the subspecies into *ex situ* seed storage and cultivation should be a priority.

Vernacular name. Virtuous Kangaroo Paw is recommended.

Affinities and notes. This rare subspecies was first brought to the attention of SDH in photos by Curtin University's Dr Katherine Downes during a study of seed germination of kangaroo paws (Downes *et al.* 2014; Downes 2016). At the time, noting the flat leaves, SDH was unaware of the population structure but suggested the taxon resembled hybrids of *Anigozanthos manglesii* × *viridis*. Consequently, it was labelled as such by Downes *et al.* (2014) and Downes (2016). Seeing a population in the wild called for a revision of this first diagnosis. The subspecies occurs in pure populations of many individuals, not intermixed with putative parental taxa as a hybrid would be expected to be. Hence, we have no hesitation in naming it as a new subspecies. The subspecies is readily distinguished from others in *A. viridis* by its flat leaves, tall scapes and rich colouration.

Figure 30. *Anigozanthos viridis* subsp. *sophrosyne*. A – whole plants in habitat; B – stamens, stigma and upper style; C – common coloured morph (right) and rare yellow morph (left); D – richly coloured inflorescence; E – close-up of flat leaves with inkspot disease; F – flat leaves and inflorescences in bud with prominently red-maroon scapes. Photographs by S.D. Hopper (A, C–F); Katherine Downes (B).

Anigozanthos yorlining Hopper, *sp. nov.*

Type: Mount Arid, southwest ridge, Cape Arid National Park,122 km east of Esperance, Western Australia, 29 November 2005, *S.D. Hopper* 8682 (*holo*: PERTH 09283722).

Illustrations. P. Nikulinsky & A. Nikulinsky, *Cape Arid*, Figure under 22 September 2009, pp. 56 & 57 (2012), as *Anigozanthos gabrielae*.

Small short-lived rhizomatous *geophyte* to 15 cm diameter and 21 cm tall. *Roots* sand-binding. *Leaves* 3.2–12 cm long by 0.5–2.5 mm wide. *Scapes* 7–21 cm long, straight, erect. *Flowers* smaller (measurements below), red and green, semi-closed, almost cleistogamous, more stiffly held obliquely erect; the green *perianth* in life 15–16 mm long, evenly tubular and united for more than half its length to just below the point of insertion of the outer filaments, when flattened out 18–20 mm long and 9–12 mm wide at base, 8–9 mm wide at narrowest point, almost parallel-sided when opened out and flattened with a slight constriction at the level of the outer stamens; *perianth lobes* split apart for their full length and spreading separately, reflexed backwards 120–180 degrees in a spreading star-like array; *style* 14–15 mm long; *anthers* at three overlapping levels held in a tightly appressed tubular bundle; outer *filament* length 1.5–2.0 mm long. (Figures 31, 32)

Diagnostic features. Erect-stemmed dwarf caespitose red and green herb to 25 cm tall. Scape straight, erect. Perianth in life evenly tubular, 15–16 mm long, when flattened out 18–20 mm long and 9–12 mm wide at base, 8–9 mm wide at narrowest point, almost parallel-sided with a slight constriction at the level of the outer stamens; style 14–15 mm long; anthers at three overlapping levels held in a tightly appressed tubular bundle; outer filament length 1.5–2.0 mm long.

Other specimens examined. WESTERN AUSTRALIA: S slope of Mount Arid, Cape Arid National Park; 122 km E of Esperance, 30 Nov. 2005, *S.D. Hopper* 8683 (PERTH 09283757); Mt Arid, slopes *c.* 1 km due southwest of summit with Mt Arid, 31 Jan. 2006, *L.S.J. Sweedman* 6775 (KPBG 21981).

Phenology. Flowers September–late November, mostly setting seed late January; cultivated specimens at Goode Beach in first flower in early August.

Distribution. A microendemic species with an extremely restricted range extending over a maximum of 4 km from near the summit of *Yorlining* (Mt Arid) south-west to 2 km east-north-east of Cape Arid. Elevation ranges from 20 to 290 m above sea level (Figure 32).

Habitat. All of the eight populations documented were found adjacent to massive sheet granite in wet shallow sand and recently burnt or unburnt granitic herbfields and low scrub with *Taxandria marginata*, *Melaleuca globifera*, *Lepidosperma hopperi*, *Hakea drupacea*, *Goodenia trinervis*, *Platysace compressa*, *Anthocercis viscosa*, *Centrolepis aristata*, *Siloxerus humifusus*, *Stylidium breviscapum*, *Isotropis cuneifolia*, *Wurmbea cernua*, *Thysanotus nudicaulis*, *Haloragodendron glandulosum*, *Verticordia minutiflora*, *Microtis quadrata*, *Cypselocarpus haloragoides*, *Stypandra glauca*, *Goodenia decursiva*, *Diuris pulchella*, *Astus tetragonus* and *Senecio glossanthus*.

Etymology. The species takes its name from the *Noongar* word for Cape Arid – *Yorlining*. This is derived from *yorl/yauwarl* = paperbark *Melaleuca*, *in/an* = kept, and in^{y} = essive case for 'as', e.g. for a character at a particular point in time (von Brandenstein 1988). Thus a translation for *Yorlining* might be where the paperbarks are kept, which is significant for Mt Arid which lies near the eastern limit for the salt water paperbark *Melaleuca cuticularis*. It seemed particularly appropriate to choose this noun in apposition for the new species as a mark of respect for the *Noongar* people of Cape Arid, the Merningar Bardoks, to whom the word Noongar itself belongs to designate a male warrior who has gone through both coastal and desert law (von Brandenstein 1988; Elder L. Knapp pers. comm.).

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora

Figure 31. Comparison of floral features of sister species *Anigozanthos yorlining* (voucher *S.D. Hopper* 8682) and *A. gabrielae* (*S.D. Hopper* 2640). *Anigozanthos yorlining*: A – inflorescence, note the fused perianth in lower half above ovary; B – plant *in situ* (with *Goodenia trinervis*) highlighting the inflorescences held on a straight, erect scape; C – flowers ventral and side view; D – inflorescence. *Anigozanthos gabrielae*: E – three flowers ventral, side and dorsal views; F – inflorescence. Photographs by S.D. Hopper.

(Tanya Llorens, pers. comm.). Careful searches in 2005/06 over Mt Arid and vicinity following a large bush fire in early 2005 revealed only eight populations of *A. yorlining*, with an estimated total of 400 + plants counted. Thus, even after seemingly ideal conditions for germination post-fire and flowering, fewer than 500 individuals have been observed by competent rare flora experts (SDH, Dr Colin Yates, Kings Park and Botanic Garden's Seed Collector Luke Sweedman). All eight populations occur within Cape Arid National Park, a place under increasing threat from successive wildfires associated with global warming. Consequently, it is recommended that *A. yorlining* be nominated as threatened under the State legislation.

Vernacular name. Cape Arid Dwarf Kangaroo Paw is recommended.

Affinities and notes. The discovery of this species by SDH and Colin Yates in November 2005 was unexpected. The genus had been comprehensively surveyed by SDH and many others over several preceding decades, including Mt Arid itself by a range of botanists. *Anigozanthos yorlining* is clearly related to *A. gabrielae*, both being diminutive red and green kangaroo paws associated with moist habitats of or near major inselbergs (Mt Arid and the Stirling Range respectively, Figure 32). However, there are many morphological differences between these two taxa on close examination. Specifically, *A. yorlining* differs from *A. gabrielae* in its scape straight, erect (vs curved, often obliquely ascending in *A. gabrielae*), smaller red and green flowers (measurements below), that are semi-closed, almost cleistogamous, more

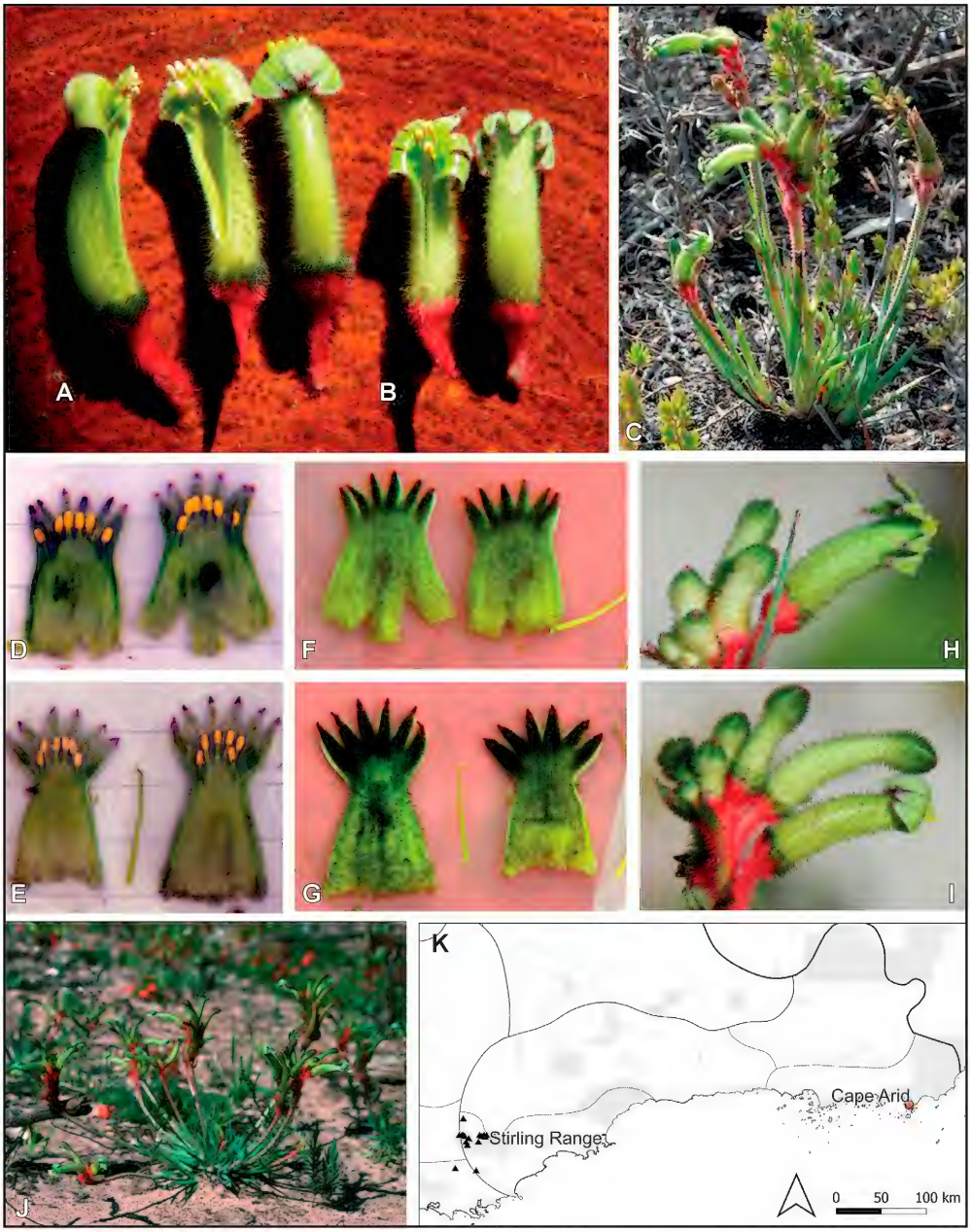

Figure 32. Comparison of floral features and distribution of *Anigozanthos gabrielae* and *A. yorlining*. *Anigozanthos gabrielae*: A – three flowers from side, ventral and dorsal views; E – two perianths cut off at the ovary and then flattened out, with style; G – dorsal view of two perianths cut off ovary and then flattened out; I –inflorescence; J – whole plant *in situ* at Camel Lake Nature Reserve N of Stirling Range, illustrating curved scapes. *Anigozanthos yorlining*: B – flowers from ventral and dorsal views; C – plant *in situ* at Yorlining (Mt Arid) illustrating straight erect scapes; D – two perianths cut off at the ovary and then flattened out; F– dorsal view of two perianths cut off at ovary and then flattened out; H –inflorescence. K – map showing geographic distribution of *A. gabrielae* (▲) (Stirling Range) and *A. yorlining* (●) (Cape Arid) based on map in Figure 1 (from Gioia & Hopper 2017). Photographs by S.D. Hopper; P. Nikulinksy (C).

stiffly held obliquely erect (vs larger flowers, somewhat tremulously held horizontal in *A. gabrielae*); the green perianth in life 15–16 mm long (vs 19–20 mm in *A. gabrielae*), evenly tubular and united for more than half its length to just below the point of insertion of the outer filaments (vs the tube unites for a third the perianth length then expands to a prominent dorsal hump before the margins flattening and narrowing at the stamens); perianth when flattened out 18–20 mm long and 9–12 mm wide at base, 8–9 mm wide at narrowest point (vs 23–26 mm long and 11–13 mm wide at base, 6–7 mm wide at narrowest point), almost parallel-sided when opened out and flattened with a slight constriction at the level of the outer stamens (vs conspicuously narrowing and constricted at the outer stamens), perianth lobes split apart for their full length and spreading separately, reflexed backwards 120–180 degrees in a spreading star-like array (vs united at the base for a third to two thirds their length, held in a tight reflexed cluster consistently at 145 degrees or more from horizontal); style 14–15 mm long (vs 15–20 mm long); anthers at three overlapping levels held in a tightly appressed tubular bundle (vs anthers splayed so that central four form a flat array at the same level above the outer two); outer filament length 1.5–2.0 mm long (vs 2.0–3.0 mm long).

In other cases in the genus such as *A. condingupensis* and *A. decrescens*, or *A. rufus* Labill. and *A. pulcherrimus* Hook., fewer characters separate clear genetic sisters. Hence we are confident that regarding *A. yorlining* as a species sister to *A. gabrielae* rather than as a subspecies of it is the appropriate taxonomic treatment. The geographical disjunction of some 500 km between these two species, combined with gravity-dispersed seed, suggests that prolonged separation in space and time has likely occurred. These are classic endemic species of OCBILs (old, climatically buffered infertile landscapes), so common in the SWAFR (Hopper 2023). Genetic studies of sisters on OCBILs in the SWAFR continue to illustrate dramatic genetic divergence, sometimes over remarkably short distances of just a few kilometres (e.g. in *Banksia seminuda* in the Walpole region on granite inselbergs – Robins *et al.* 2021).

The semi-closed, almost cleistogamous flowers of *A. yorlining* are unique in the genus. The perianth is tubular almost up to the stamens, which therefore are tightly bundled around the style (Figures 31, 32). Cross-and self-pollination studies may prove rewarding, given that most species are strongly xenogamous (Hopper 1980).

Anigozanthos yorlining adds to the list of dwarf kangaroo paws that are pollinated by honeyeaters standing on the ground (Hopper 1993). Outgroup comparison suggests that this is the ancestral form for the kangaroo paws – species of *Conostylis* and of *Blancoa* that are bird-pollinated are all short-statured and nectar is consumed from a standing position on the ground. An experimental study of feeding behaviours of honeyeaters on kangaroo paws of differing scape heights may well provide further insight on this process.

Undoubtedly, *A. yorlining* is the most vulnerable species in the genus to the effects of climate change, given it has such a narrow range confined to the summit and southern slopes of the Mt Arid massif. Regular monitoring of the species is needed, and further seed collections made, to ensure it survives *ex situ* at least, should wild populations go extinct.

Conostylis R.Br.

Conostylis is the largest genus of Haemodoraceae, sister to *Blancoa*, and now comprising 49 species, with four recognised as new or elevated to species rank herein. The genus has been examined from a molecular phylogenetics perspective (Hopper *et al.* 2006; Zuntini *et al.* 2021), calling for a revision of the infrageneric classification offered by Hopper *et al.* (1987) now that it is evident that vertebrate-pollinated flowers arose independently four times in *C.* subg. *Pendula* Hopper, and other relationships have been clarified. New taxa and species are described below.

Conostylis subg. **Appendicula** (Geerinck) Hopper, *comb. et stat. nov.*

Conostylis sect. *Appendicula* Geerinck, *Bull. Jard. Bot. Etat.* 39: 64 (1969). *Type*: *C. aurea* Lindl.

Conostylis subg. **Divaricata** (Hopper) Hopper, *comb. et stat. nov.*

Conostylis sect. *Divaricata* Hopper, *Fl. Australia* 45: 457 (1987). *Type*: *C. phathyrantha* Diels

Elevated to subgeneric status on the basis of molecular phylogenetic evidence (Hopper *et al.* 2006). *Conostylis neocymosa* Hopper is removed from this subgenus due to its ovules being few, reflexed from the underside of the placenta. This key character is diagnostic of *Conostylis* subg. *Pendula* Hopper. *Conostylis* subg. *Divaricata* is thereby rendered monotypic, distinguished by its placenta covered with ovules on lateral and lower sides and its loosely cymose inflorescence.

Conostylis R.Br. sect. **Conostylis**.

Type: *C. aculeata* R.Br.

Differs from *C.* sect. *Terraflora* Hopper by many-flowered inflorescences borne well above the soil on elongate scapes.

A section of ten species, highly variable with subspecies especially in *C. aculeata* and *C. candicans* Endl. Natural hybridisation is frequent at interzones between habitats occupied by parental taxa. At least three stabilised hybrids are formally recognised as taxa – *C. pauciflora* Hopper subsp. *pauciflora*, *C. pauciflora* subsp. *euryrhipis* Hopper and *C. bracteata* Lindl. *Conostylis stylidioides* F.Muell. is likely an ancient allopolyploid (Krauss & Hopper 2001).

Conostylis sect. **Terraflora** Hopper, *sect. nov.*

Type: *C. serrulata* R.Br.

A section distinguished by the compact or loose relatively few-flowered cymose or umbellate inflorescences on short scapes held at or close to ground level.

Etymology. From the Latin *terra* (land) and *-floris* (flower), alluding to the flowers being held at close proximity to the ground.

Affinities and notes. Five species are included in *C.* sect. *Terraflora*: *C. serrulata*, *C. glabra* Hopper, *C. juncea* Endl., *C. laxiflora* Benth. and *C. magna* Hopper. These species are quite divergent morphologically from each other, a pattern also evident in the number of changes in DNA sequences documented (Hopper *et al.* 2006). *Conostylis juncea*, with its unique bristle-like floral hairs, is quite variable vegetatively and warrants further taxonomic study. Two new local endemics of the northern sandplains in *C.* sect. *Terraflora* have been discovered and are described below.

Conostylis glabra Hopper, *sp. nov.*

Type: Watheroo National Park, Western Australia [precise locality withheld for conservation reasons], 6 October 1997, *S.D. Hopper* 8394 (*holo*: PERTH 09323414; *iso*: CANB).

Conostylis sp. Watheroo (S.D. Hopper 7668), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 22 May 2025].

Conostylis glabra Hopper ms, in R.J. Smith, S.D. Hopper & M.W. Shane, *Plant Soil* 348: 466 (2011), *nomen nudum*.

Caespitose tufted shiny *perennial herb* in clumps up to 50 cm diameter, 60 cm wide, glabrous, viscid. *Roots* sand-binding. *Leaves* clearly striate with *c.* 10 parallel veins raised above lamina, linear to slightly falcate,

flat, to 30–50 cm long, 5–12 mm wide, slightly glossy green becoming yellowish cream and very viscid near base; margins yellow-green or brown near base with minute upward facing pointed indurate bristles every 2–5(–10) mm. *Inflorescence* geoflorous, a compact or loose cyme, basal, very viscid, much shorter than leaves, 3–7 cm long, to 5-flowered. *Bracts* 2–4, scarious, conduplicate, yellow-cream, lanceolate to navicular, to 4 cm, 7 mm wide basally, becoming narrow linear and 2 cm, 0.5 mm, scarious, brown. *Floral bracts* very narrow linear, to 0.5 mm wide, 25 mm long. *Pedicels* pale greenish yellow, 0.5–1.5 cm long. *Flowers* greenish yellow, glossy. *Perianth* divided for four-fifths of length; *lobes* 7–11 mm long, glossy pale yellow with white margins abaxially, cream adaxially, becoming golden yellow at base, apical margins ferruginous, dark brown. *Stamens* erect, held away from spreading perianth. *Anthers* cream, 4–6 mm long on a 1.5–2.5 mm golden yellow filament. *Style* pale greenish yellow, *c.* 5–8 mm long. *Stigma* as long astop of anthers. *Ovary* glossy pale green on sides, golden yellow on top, 9–12 mm long. *Ovules* 30 or more per locule, all over a small placenta. *Seeds* narrow-elliptic, orange-brown undulating surface with white clusters of 3–4 linear marks. (Figure 33)

Diagnostic features. *Conostylis glabra* is the only mostly glabrous species in the genus. The species has striate leaves to 500 mm long, 10 mm wide, margins with minute upward facing pointed indurate bristles every 2–5 mm. Inflorescence geoflorous, of up to 5 flowers, much shorter than the leaves. Flowers greenish yellow, glossy. Perianth is divided for four-fifths of perianth length, the lobes are 7–11 mm long. Anthers are erect, held away from the spreading perianth, cream, 4–6 mm long on a filament 1.5–2.5 mm long. Style pale greenish yellow, *c.* 5–8 mm long, stigma equalling top of anthers. Ovules 30 or more per locule, all over a small placenta.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 13 Oct. 1989, *S.D. Hopper* 7668 (BRI, CANB, MEL, NSW, PERTH 09214607); 10 Oct. 2008, *L.S. Sweedman* 7456 & *S.D. Hopper* (PERTH 08764247, K).

Phenology. Flowers September–early October.

Distribution. Endemic to Watheroo National Park in the border of the Lesueur-Wongan Botanical Districts of the Southwest Australian Floristic Region (*sensu* Gioia & Hopper 2017, Figure 1).

Habitat. Confined to gradually rising hills of deep sand supporting low woodlands of *Callitris arenaria*, *Banksia prionotes*, *B. attenuata*, *B. burdettii* and *Xylomelum angustifolium* over shrubs of *Acacia*, *Lachnostachys eriobotrya*, *Calytrix*, *Synaphea*, *Hakea orthorrhyncha*, *Conospermum*, *Melaleuca*, *Petrophile*, *Verticordia*, *Daviesia*, *Jacksonia horrida*, *Stirlingia latifolia*, *Adenanthos cygnorum*, *Leptospermum*, *Eremaea pauciflora*, *Lysinema ciliatum*, *Banksia leptophylla* and *Isopogon drummondii* over very open perennial herbs of *Patersonia*, *Mesomelaena*, *Drosera* spp., *Thysanotus* and *Desmocladus flexuosus*.

Etymology. From the Latin adjective *glaber*, *-ra*, *-rum* = hairless, in reference to the almost hairless state of the whole plant.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Conostylis* sp. Watheroo (S.D. Hopper 7668). *Conostylis glabra* is presently known from four populations on firebreaks within Watheroo National Park. Population estimates range from 200 plants to ten plants.

Vernacular name. Glabrous Cottonhead is recommended.

Affinities and notes. Molecular phylogenetic studies (Hopper *et al.* 2006; Zuntini *et al.* 2021) place *Conostylis glabra* as sister to a clade of *C. juncea*, *C. serrulata* and *C. laxiflora* (with significant missing sequences and poor support at the *mat*K and ITS loci), or sister to *C. serrulata* with 95% bootstrap support and 17 changes evident indicating considerable evolutionary divergence. Hence *C. glabra* may be

Figure 33. *Conostylis glabra*. A – whole plant *in situ*; B – habitat in Watheroo National Park; C – sectioned half flower showing erect stamens and placentation; D – flowers open and recently finished; E – same illustrating erect stamens; F – inflorescence in young fruit; G – microscopic view of seed; H – excavated whole plant showing sand-binding roots; I – viscid leaf bases and young fruiting inflorescences; J – close up of sand-binding roots. Photographs by S.D. Hopper (A–F, H–I); L. Sweedman (G).

reasonably regarded as a somewhat isolated endemic species of *C.* sect. *Terraflora* confined to Watheroo National Park sandplains.

Conostylis glabra is readily distinguished from *C. serrulata, C. juncea* and *C. laxiflora* in its glabrous plants with glossy yellow-green flowers (*C. juncea* with very long scattered hairs on yellow-green and white flowers; *C. laxiflora* with a loosely villous short-haired creamy yellow and green perianth; flowers cream and finely hirsute in *C. serrulata*), leaves glossy green with margins with minute upward facing pointed indurate bristles every 2–5 mm (usually dull blue-green leaves with minutely denticulate-serrulate margins in *C. serrulata*), pedicels glabrous and pale greenish yellow, 1–1.5 cm long (vs minutely hirsute, pale greenish cream, to 6 mm long in *C. serrulata*), erect stamens held away from the spreading perianth (vs reclined against the perianth in *C. serrulata*). *Conostylis glabra* and *C. serrulata* have a compact or loose, cymose, few-flowered inflorescence *c.* 5 cm tall (less than a tenth the length of the leaves), whereas *C. juncea* has a shortly capitate inflorescence, ground-hugging and many flowered, while *C. laxiflora* has a loose cyme to 15 cm tall, several-flowered, up to a third the length of the leaves.

The discovery of such a morphologically distinctive endemic by SDH in 1989 came as a surprise given the extensive field surveys conducted on *Conostylis* at the time. The species remains poorly collected to the present day, in need of detailed survey within the narrow confines of its known range. At present it appears to be the only narrow endemic plant confined to Watheroo National Park.

Conostylis magna Hopper, *sp. nov.*

Type: Alexander Morrison National Park [precise locality withheld for conservation reasons], 6 October 1997, Western Australia, *S.D. Hopper* 8395 (*holo*: PERTH 09323538; *iso*: K ex PERTH 09323546).

Conostylis sp. Eneabba (M. Hislop 3864), Western Australian Herbarium, in *Florabase*, https://florabase.dbca.wa.gov.au/ [accessed 22 May 2025].

Conostylis magna Hopper ms, in R.J. Smith, S.D. Hopper & M.W. Shane, *Plant Soil* 348: 466 (2011), *nomen nudum.*

Caespitose *herb* in clumps up to 50 cm diameter, 65 cm wide. *Roots* sand-binding. *Leaves* glabrous, green when young with acute scarious apex, greyish green to blue-green, striate with 9–12 prominent parallel longitudinal veins with conspicuous yellow marginal veins, 26–65 cm long, 4.5–7 mm wide. *Inflorescence* geoflorous, to 12 cm high, a compact or loose cyme, branches hidden by densely aggregated flowers above. *Bracts* broadly navicular to linear, dark brown, scarious, mostly glabrous except for the tightly tomentose base with creamy yellow hairs, to 30 mm long, 13 mm wide, apex acute. Flowers creamy yellow, tightly tomentose outside, inner perianth lobes evenly tricoloured with brown apices and apical margins, cream medially and becoming gold in basal third. *Perianth lobes* free, splayed widely, scarcely connate, closing with perianth lobes vertical and separated by clearly visible gaps, 7–9 mm long. *Anthers* 4–5 mm long, reclined parallel to splayed perianth lobes, cream, on short golden filaments *c.* 1 mm long. *Style* golden, short (*c.* 2–3 mm long), its base flaring obliquely to form a golden broad cone atop the ovary. *Stigma* simple. *Seeds* not seen. (Figure 34)

Diagnostic features. *Conostylis magna* may be distinguished from all other members of the genus by the following combination of characters. Caespitose herb. Sand-binding roots. Large glabrous, greyish green to blue-green leaves, 26–48 cm long, 4.5–7 mm wide, with smooth yellow margins. Geoflorous inflorescence to 12 cm tall, a compact or loose cyme, branches hidden by densely aggregated flowers above; bracts broadly navicular to linear, dark brown, scarious, mostly glabrous except for the tightly tomentose base with creamy yellow hairs; flowers creamy yellow, tightly tomentose outside, inner perianth lobes evenly tricoloured with brown apices and apical margins, cream medially and becoming gold in basal third; perianth lobes free, splayed widely, scarcely connate, 7–9 mm long. Anthers 4–5 mm long, reclined parallel to splayed perianth lobes, cream, on short golden filaments *c.* 1 mm long.

Figure 34. *Conostylis magna*. A – leaves and inflorescences; B – close-up of bud, flowers and closed flowers; C – whole plant. Photographs by S.D. Hopper.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 Sep. 2005, *L. Aerne* LA 38 *& S.D. Hopper* (PERTH 08643970); 9 Sep. 2004, *R.K. Brummitt* RKB 21198, *A.S. George & E.G.H. Oliver* (PERTH 06962238); 10 Aug. 2014, *R. Davis* RD 12456 *& K.R. Thiele* (PERTH 08616183, 08633312,); 21 Oct. 1987, *E.A. Griffin* 4716B (PERTH 04365453); 17 Nov. 2008, *M. Hislop* 3864 (CANB, PERTH 08182043); 11 Oct. 1989, *S.D. Hopper* 7661 (PERTH 07440472); 27 Aug. 2015, *G.J Keighery & B.J. Keighery* 2760 (PERTH 09203273); 8 Oct. 2008, *R.J. Smith* 173, *S.D Hopper & L. Sweedman* (PERTH 08804133); 8 Oct. 2008, *L.S.J. Sweedman* 7451 & *S.D. Hopper* (PERTH 08764255).

Phenology. Flowers September–early October.

Distribution. Endemic to the Alexander Morrison National Park district in the Lesueur Botanical District of the Southwest Australian Floristic Region (*sensu* Gioia & Hopper 2017).

Habitat. Grows in kwongkan in deep white sand high in the landscape (i.e. on OCBILs) with *Eucalyptus todtiana*, *Banksia attenuata* and *B. burdettii* 3–5m tall very open low woodland over heath and scrub of *Banksia candolleana*, *B. micrantha*, *B. shuttleworthiana*, *Eremaea*, *Conospermum*, *Jacksonia*, *Adenanthos cygnorum*, *Verticordia*, *Lechenaultia*, *Dasypogon*, *Hovea stricta*, *Hibbertia subvaginata*, *Synaphea spinulosa*, *Calothamnus sanguineus*, *Stirlingia*, *Lambertia multiflora*, *Hakea orthorrhyncha*, *Caustis* sedges, *Conostylis seminuda*, *C. teretifolia*, *C. crassinerva* ssp. *absens*, *Haemodorum venosum*, *Macropidia fuliginosa* and *Phlebocarya pilosissima* subsp. *pilosissima*.

Etymology. From the Latin adjective *magnus, -a, -um* = large, alluding to the larger dimensions of the plant compared with its possible sister species *C. serrulata*.

Conservation status. Listed as Priority Two under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–), as *Conostylis* sp. Eneabba (M. Hislop 3864).

Vernacular name. Large Cottonhead is recommended.

Affinities and notes. First collected by E.A. Griffin in 1987, and then two years after by SDH in 1989, *Conostylis magna* was another surprising discovery within the Lesueur Botanical District as its morphological affinities appear to be clearly with the more southerly species *C. serrulata* of forest and woodlands. *Conostylis magna* differs from *C. serrulata* primarily in its longer leaves (to 48 cm vs 40 cm) with prominent, yellow-veined, glabrous leaf margins (vs thin margins with minutely denticulate-serrulate hairs). The tricolour pattern of the inner perianth segments of *C. magna* is not as well-marked in *C. serrulata*, which may become uniformly golden coloured in some populations. Buds and the outer perianth segments of *C. magna* are brownish/golden yellow whereas they are creamy yellow in *C. serrulata*.

Despite the close morphological similarities of these two species, which led SDH to initially consider subspecific status for *C. magna*, DNA sequencing revealed substantial differences. However, the *C. magna* sample had significant missing sequences so its placement in the phylograms (Hopper *et al.* 2006) may be dubious. Nevertheless, we here place *C. magna* with its likely sister *C. serrulata* and allies in *C.* sect. *Terraflora*.

There are no other species in *Conostylis* that could be readily confused with *C. magna*. For example, *C. glabra* differs from *C. magna* in lacking any hairs and having glossy yellow inflorescences and leaf bases (Figure 33).

Conostylis aculeata R.Br. subsp. **bolghinup** Hopper, *subsp. nov.*

Type: Black Point, Lake Bolghinup, Western Australia [precise locality withheld for conservation reasons], 10 April 2014, *S.D. Hopper* 8690 (*holo*: PERTH 09723153; *iso*: CANB, K, MEL, PERTH 09865497).

Loosely caespitose robust perennial *herb* to 50 cm high. *Stems* stoloniferous, 6–16 cm long. *Leaves* to 50 cm long by 3–7 mm wide, in loosely flattened, narrowly fan-shaped clusters; marginal nerve inconspicuous; bristles along whole margin, spaced 3–5 mm apart, tightly angled upwards, usually 1–2 mm long. *Inflorescence* a compact terminal cyme or raceme; scape simple, erect, 16–30 cm tall, the flowers held at *c.* three-quarters the length of the leaves. *Flowers* 11–15 mm long. (Figures 35, 36)

Diagnostic features. Robust herb to 50 cm high; stoloniferous stems 6–16 cm long; leaves to 50 cm long, 3–7 mm wide, marginal nerve inconspicuous, bristles along whole margin, tightly angled upwards, usually 1–2 mm long; inflorescence compact, terminal, scapes to *c.* three-quarters the length of the leaves; flowers 11–15 mm long.

Other specimens examined. WESTERN AUSTRALIA: None seen, other than S.D. Hopper's field collection number 83313 under sticky tape in fieldbook 94 p. 40, collected at the type locality on 6 November 2014.

Phenology. Flowers October–December.

Distribution. *Conostylis aculeata* subsp. *bolghinup* occurs in the Muir Botanical District (Gioia & Hopper 2017), where it is endemic to the low dunes atop the Black Point basalt peninsula within D'Entrecasteaux National Park. This location also has a morphologically distinct population of *Banksia occidentalis* (Hopper 1989; Robins *et al.* 2024) and is the only known place of occurrence in Western Australia of *Plantago australis*, a species otherwise confined to Victoria.

Habitat. Grows in coastal low scrub of *Agonis flexuosa* 1.5 m tall with *Anthocercis littorea*, *Olearia axillaris*, *Cassytha*, *Desmocladus flexuosus*, *Jacksonia*, *Ficinia nodosa*, *Lepidosperma gladiatum*, *Acacia cyclops*, *A. littorea*, *Scaevola crassifolia*, *Banksia sessilis*, *B. occidentalis*, *Hibbertia stellaris*, *Adenanthos meisneri*, *Ornduffia parnassifolia*, *Patersonia*, *Brachyscome iberidifolia*, *Olax phyllanthi*, *Xanthorrhoea preissii*, *Muehlenbeckia adpressa* and marram grass (*Ammophila arenaria*). Coastal dunes are of yellowish sand with occasional limestone outcropping.

Etymology. Named from the small Lake Bolghinup on Black Point. *Bolghinup* is a Noongar word also rendered as *Bolganup* in the Porongurup Range. Hassell (1940) indicated that *Bolganup* meant place of the old ghosts or spirits. Given that it starts with *bol/bal* which means he, him, she, them, it and don't, leave it, finish with, beware (von Brandenstein 1988; Bindon & Chadwick 1992), the name *Bolganup/ Bolghinup* seems to signify a very special place, full of ancestral spirits that command respect, reverence and caution. The robust bristle-laden leaves of *C. aculeata* subsp. *bolghinup* do indeed command respect, and the home of this subspecies is well known as a special place for camping and tool making (Figure 35) by Noongars.

Conservation status. A narrow endemic that is locally scarce to common. However, surveys southeast and northwest adjacent the coastline are yet to be undertaken to determine whether or not it is a true endemic of Black Point alone, although 7 km due east of Black Point on limestone *C. aculeata* subspp. *aculeata/ gracilis* intergrades are to be found (Figure 36). It is best, for the time being, for *C. aculeata* subsp. *bolghinup* to be regarded as of indeterminate conservation status.

Vernacular name. Black Point Spiny Cottonhead is recommended.

Affinities and notes. *Conostylis aculeata* subsp. *bolghinup* is the most robust subspecies known, attaining

Figure 35. *Conostylis aculeata* subsp. *bolghinup*. A – view south-east at dry Lake Bolginup in February dominated by brown sedges, Black Point; B – fruiting inflorescence and typically broad leaves reddening towards the base; C, G – flowering inflorescence in November; D–F, H, I – Noongar artefacts collected at Black Point mostly by the late George Gardner, not to same scale, including hand-held grinding stone, black obsidian blade (a very rare rock in Noongar country [E]), backed blade of basalt, large chopper, grinding stone; J – single inflorescence and leaf fan; K – whole plants on bare dunes; L – close up of leaves showing obliquely ascending marginal spines; M – close-up of flowers showing six stamens and trifid stigma. Photographs by S.D. Hopper, courtesy George Gardner Museum Northcliffe (D–F & H–I) .

Figure 36. A – *Conostylis aculeata* subsp. *aculeata/gracilis* intergrades from 7 km E of Black Point on calcareous grey loam and limestone; B – *C. aculeata* subsp. *bolghinup* from Black Point illustrating longer, broader leaves and longer stem segments. Photographs by S.D. Hopper.

a height up to 50 cm, and with the broadest leaves 3–7 mm wide (Figures 35, 36). It is embedded within the geographic distribution of *C. aculeata* subsp. *aculeata* and possibly *C. aculeata* subsp. *gracilis* Hopper (Figure 36), but distinguishable by most of the characters listed above under diagnostic features. *Conostylis aculeata* subsp. *cygnorum* Hopper is another robust subspecies which differs from *C. aculeata* subsp. *bolghinup* in its globular inflorescence held above the leaves and in its leaves with a prominent yellow marginal vein and bristles confined to the apical half of the leaf.

Conostylis bungalbin Hopper, *sp. nov.*

Type: Helena and Aurora Range, Bungalbin Hill, Western Australia, 4 September 1984, *S.D. Hopper* 4038 (*holo*: PERTH 09276920).

Long-lived rhizomatous herbaceous obligate-seeding *perennial* lithophile forming clumps to 50 cm diameter and 20 cm high. *Roots* tough, wiry. *Leaves* flat, narrowly linear, to 23 cm long, 1.6–2 mm wide, grey-green, hairy and villous; *margins* with short tightly appressed bristles. *Floral bracts* ventricose, 20–22 mm long, 7 mm wide near base, scarious, thin, dry, opaque, apex acute, brown, attaining base of perianth lobes. *Flowers* solitary, 39–40 mm long with obliquely ascending never reflexed perianth lobes for *c.* half the length of the perianth; dark purple hairs on outside of perianth lobes for *c.* upper two-thirds of lobe length; perianth tube straight, pale green, *c.* 10 mm diameter. *Stamens* pale yellow-green; filaments *c.* 8 mm long; anthers 5–6 mm long. *Style c.* 32 mm long, green with green stigma. *Placentation and seeds* not seen. (Figures 37, 39)

Diagnostic features. *Conostylis bungalbin* is distinguished from other *Conostylis* in its tufted caespitose habit, banded ironstone habitat, short narrow villous leaves, its floral bracts half the length of the perianth, the straight perianth with dark purple hairs on the outside of the perianth lobes for two-thirds the length of the lobes, and its green style to 32 mm long with a green stigma.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 26 July 1995, *N. Gibson* & *M. Lyons* 3361 (PERTH 05393191); 15 May 1978, *G.J. Keighery* 1759 (PERTH 02011492); 2 Nov. 2000, *M. Sheriff* 217 - MS 217 (K, NSW, PERTH 06342728).

Figure 37. *Conostylis bungalbin*. A – plants *in situ* atop Bungalbin Hill, A.P. Brown for scale, 3 September 1984; B – buds and leaves; C – leaf fans atop stilt roots penetrating rock fissures *in situ*; D – flowers and leaves; E – flower – note the green style (arrowed). Photographs by G. Cockerton (B, D, E); S.D Hopper (A, C).

Phenology. Recorded in flower early August.

Distribution. Endemic to the Helena and Aurora Range, notably at Bungalbin Hill (Figure 39).

Habitat. Grows in fissures in banded ironstone with *Neurachne annularis* (Conservation status P3), *Tetratheca aphylla* subsp. *aphylla* (Threatened), *Lepidosperma bungalbin* (Threatened), *Stenanthemum newbeyi* (P3) and *Banksia arborea* (P4). Other associated species include *Acacia shapelleae* (Threatened), *Ptilotus obovatus*, *Melaleuca nematophylla*, *M. filifolia*, *Allocasuarina acutivalvis*, *Chamaexeros macranthera*, *Alyxia buxifolia*, *Dianella revoluta*, *Melaleuca leiocarpa* (BIF Form), *Grevillea zygoloba*, *Eucalyptus ebbanoensis* and *Calycopeplus paucifolius*. The occurrence of so many associated species of conservation concern in the Helena and Aurora Ranges led to their proposal as a national park in 2021.

Etymology. The specific epithet, a noun in apposition, is a Kalamia Kapurn (Gubrun) traditional name for the Helena and Aurora Ranges.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (Tanya Llorens pers. comm.). *Conostylis bungalbin* is a narrow endemic confined to the Helena and Aurora Ranges and one location (Koolyanobbing) further south. Its conservation status requires further investigation. At present the Helena and Aurora Ranges is a proposed National Park, although several mining tenements are still current over the habitat of *C. bungalbin*.

Vernacular name. Bungalbin Conostylis is recommended.

Affinities and notes. *Conostylis bungalbin* is sister to the widespread *C. argentea* (J.W.Green) Hopper (Figures 38–39), from which it differs in its somewhat larger broader leaves, its floral bracts half the length of the perianth, the perianth tube straight, dark purple hairs confined to two-thirds the length of the perianth lobes, and its shorter green style and green stigma.

Conostylis bungalbin is a banded ironstone inselberg endemic apparently restricted to just two inselbergs – Bungalbin Hill and Koolyanobbing Range. It is noteworthy in being the only species of *Conostylis* found outside the boundaries of the SWAFR *sensu* Gioia and Hopper (2017).

Figure 38. *Conostylis argentea*. A – leaves, bud and flower with black style arrowed; B – plant *in situ*, foreground, Tarin Rock, 10 August 2015; C – flower showing black style (arrowed); D – close-up of four flowers, Bald Rock Creek, Old Ongerup Road. Photographs by S.D. Hopper.

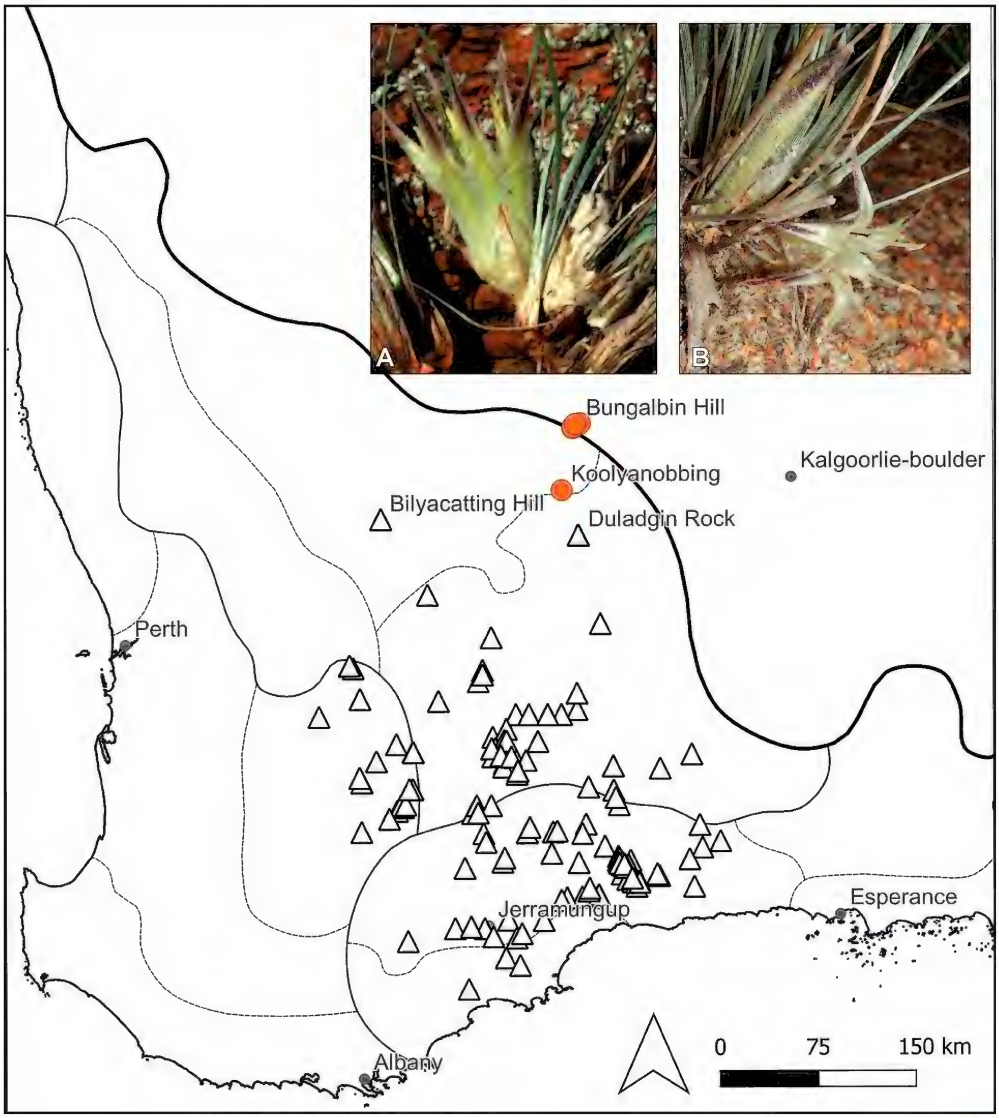

Figure 39. *Conostylis bungalbin* (A) and *C. argentea* (B) plus map of specimen distributions of *C. bungalbin* (●), *C. argentea* (△), specimen locations from *Atlas of Living Australia* accessed 11 Sept 2022. Map of the Southwest Australian Floristic Region shows location in relation to Botanical Provinces and Districts recognised by Gioia and Hopper (2017) – see Figure 1.

Conostylis dasys (Hopper) Hopper, *comb. et stat. nov.*

Basionym: *Conostylis setigera* subsp. *dasys* Hopper, *Fl. Australia* 45: 463 (1987). *Type*: north of Kojonup, Western Australia [precise locality withheld for conservation reasons], 12 November 1985, *S.D. Hopper* 4707 (*holo*: PERTH 01036246; *iso*: AD, CANB, MEL).

This combination is based on DNA evidence (Hopper *et al.* 2006), which places *C. dasys* as sister to *C. teretifolia* J.W.Green, not *C. setigera* R.Br., with moderate support.

Conostylis robusta Diels subsp. **hickmaniae** Hopper, *subsp. nov.*

Type: 200 m west of Ogilvie Road on verge *c.* 5.3 km S of George Grey Drive intersection, 18 km (bearing 350°) north of Gregory, Western Australia, 31 August 1997, *S.D. Hopper* 8390a (*holo*: PERTH 09323376; *iso*: PERTH 09323384).

Erect, procumbent to climbing *perennial herb*, usually to 40 cm tall, occasionally to 130 cm. *Stem segments* 5–15 cm long. *Leaves* 120–250 mm long, 4–8 mm wide. *Scape* 23–40 cm long, exceeding leaves. (Figures 40–43)

Other specimens examined. WESTERN AUSTRALIA: southern boundary, Kalbarri National Park on S side of Vermin Proof Fence, 21 Oct. 1974, *J.S. Beard* 7126 (PERTH 02103214); Kalbarri National Park, S of township between Red Bluff and Park boundary, 21 Sept. 1982, *M.G. Corrick* 8145 (PERTH 02103095); 47 km NW of Northampton, 1.2 km E of Yerina Springs road along West Ogilvie road, 19 Aug. 1975, *S.D. Hopper* 588 (PERTH 02103087); 2.5 km E of Meanara Hill, Kalbarri National Park, 13 Sep. 1979, *S.D. Hopper* 1268 (PERTH 07295898); 1 km SE of Junga Dam, Kalbarri National Park, 13 Sep. 1979, *S.D. Hopper* 1299 (PERTH 07295901); mouth of Murchison River, 1965, *W. Rogerson* 222 (PERTH 02103265); Junga Tank, 25 Sep. 1953, *N.H. Speck* 966 (PERTH 02102943).

Phenology. Flowers September.

Distribution. *Conostylis robusta* subsp. *hickmaniae* occurs in the Kalbarri Botanical District (Gioia & Hopper 2017), where it is endemic in kwongkan near the coast south of the Murchison River (Figure 42).

Habitat. Grows on crests and slopes of rolling coastal hills in scrub to 3 m tall of *Acacia ligulata*, *A. spathulifolia*, *A. teretifolia*, *Allocasuarina campestris*, *Banksia menziesii*, *B. victoriae*, *B. attenuata*, *Nuytsia floribunda*, *Grevillea leucopteris*, *Olearia revoluta*, *Dianella revoluta*, *Ptilotus polystachyus*, *Melaleuca*, *Jacksonia*, *Enchylaena*, *Ecdeiocolea* and *Hibbertia*. Also inland in coarse pale yellow sand among foothills with *Acacia scirpifolia* (2–3 m), scattered *Grevillea leucopteris* (2–3 m) and *Chamelaucium uncinatum* (1–1.5 m) over dwarf scrub and sedges.

Etymology. Named for Dr Ellen J. Hickman, gifted prize-winning botanical artist and author/artist of several illustrated biological books, as well as scholarly articles associated with botanical art and taxonomy. Ellen is a coauthor of the present paper, and has worked with SDH and RJS in the field on Haemodoraceae for many years, bringing to life some of the extraordinary colour variation now known in this family through her meticulously crafted artwork (e.g. several figures herein). Ellen was travelling with SDH on the field trip that was key to identifying the subspecific characters distinguishing the two subspecies in *C. robusta*.

Conservation status. A narrow endemic, common in Kalbarri National Park, and not under threat.

Vernacular name. Hickman's Cottonhead is recommended.

Affinities and notes. *Conostylis robusta* subsp. *hickmaniae* is the tallest taxon in the genus, attaining up to 1.3 m when pushing up through dense kwongkan. Even in more open conditions, the subspecies attains heights of *c.* 40 cm. It varies in habit, from erect, procumbent to climbing, to tightly caespitose (Figure 40). It is a near-coastal form, differing from the typical inland *C. robusta* subsp. *robusta* (Figure 42) in its longer stem segments (5–15 cm vs 0–6 cm, rarely longer) and shorter leaves (12–25 cm vs 28–54 cm). The two subspecies of *C. robusta* hybridise inland from Kalbarri, and intergrade on the margins of southern populations of *C. robusta* subsp. *robusta* (Figure 42).

Figure 40. *Conostylis robusta* subsp. *hickmaniae* with Ellen Hickman illustrating the range of plant habits found in the subspecies within Kalbarri National Park (Red Bluff, A) and immediately south (B–F). A – broadly caespitose/procumbent; B, C – vine-like erect plant to 1.3 m tall through extension of stem segments in dense *Banksia attenuata* kwongkan; D – evenly caespitose on moderately extended stem segments; E – caespitose with some longer stem segments post-fire; F – tightly caespitose on shorter stem segments. Photographs by S.D. Hopper.

Figure 41. *Conostylis robusta* subsp. *hickmaniae* from Red Bluff, Kalbarri National Park (B, E) and inland to the south-east (A, C, D, F, G). A – young plant post-fire with dark red new stem segments; B – pale-coloured globular inflorescence with white inner perianth lobes; C – golden yellow and white inflorescence with more typical golden yellow inner perianth lobes, almost white towards the apex; D – mature leaf bases off stem segment with some red colouration ; E – underside of inflorescences showing bracts; F – mature blue-green leaf with marginal bristles; G – whole plant, with *Anigozanthos manglesii* subsp. *quadrans*, post-fire. Photographs S.D. Hopper.

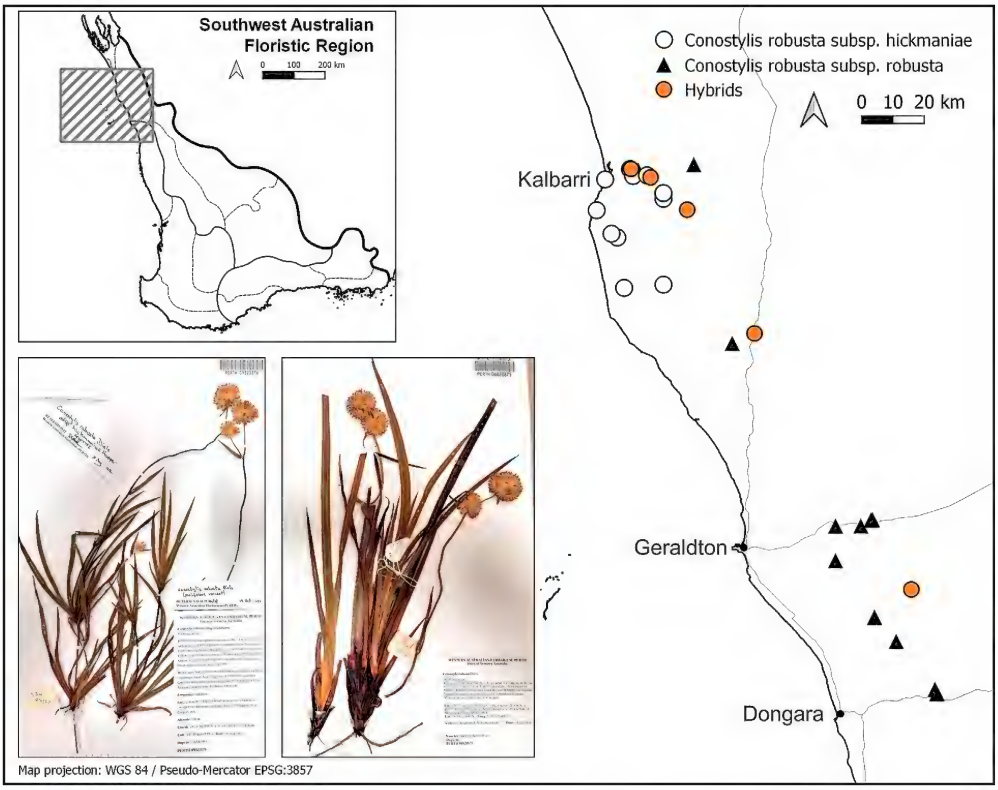

Figure 42. Geographical distribution of *Conostylis robusta* subsp. *hickmaniae* (○), *C. robusta* subsp. *robusta* (▲) and hybrids or intergrades of the two subspecies (●). Top inset: hatched box shows location within the Southwest Australian Floristic Region *sensu* Gioia and Hopper 2017 (see Figure 1). Bottom insets: highlighting relative leaf and inflorescence dimensions of *C. robusta* subsp. *hickmaniae* (left) and *C. robusta* subsp. *robusta* (right). Photographs by S.D. Hopper.

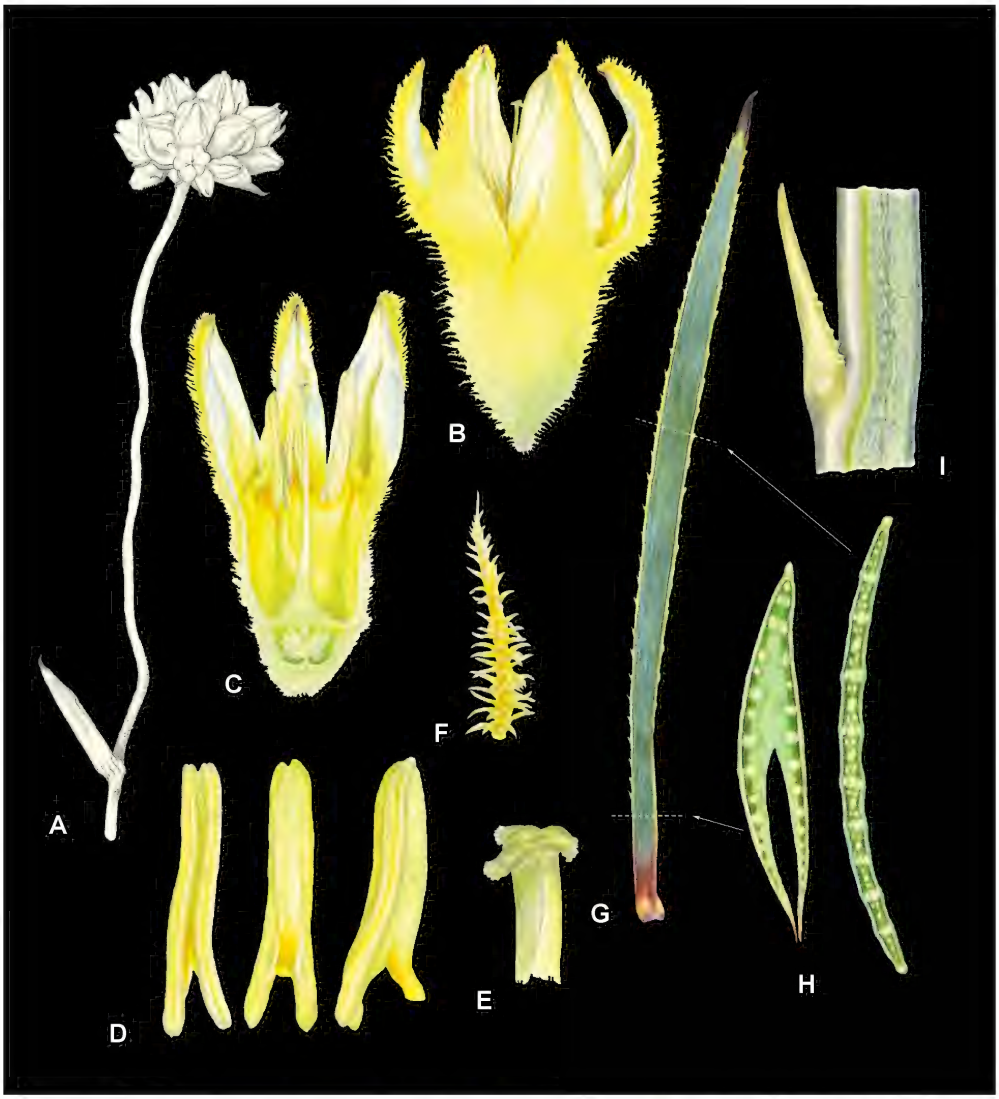

Figure 43. *Conostylis robusta* subsp. *hickmaniae* from Red Bluff, Kalbarri National Park. A – inflorescence; B – whole flower; C – sectioned half flower; D – anthers; E – stigma; F – floral hair; G – leaf; H – leaf transverse sections; I – spine on leaf margin. Illustrations by E.J. Hickman.

Updated Classification for Haemodoraceae

To help navigate the following checklist, Table 4 provides an updated classification including the ranks of Subfamily, Tribe, Genus, Subgenus and Section recognised herein.

Table 4. Updated classification for Haemodoraceae.

Subfamily	Tribe	Genus	Subgenus	Section
Haemodoroideae R.Br.	*Haemodoreae* R.Br.	*Dilatris* P.J.Bergius		
		Haemodorum Sm.	*Haemodorum* Sm.	
			Antiqua Hopper & R.J.Sm.	
			Gemina Hopper & R.J.Sm.	
		Lachnanthes Elliott		
		Paradilatris (Hopper ex J.C.Manning) Hopper		
	Wachendorfieae Dumort.	*Barberetta* Harv.		
		Cubanicula Hopper, J.E.Gut., E.J.Hickman, M.Pell. & R.J.Sm.		
		Pyrrorhiza Maguire & Wurdack		
		Schiekia Meisn.		
		Wachendorfia Burm.		
		Xiphidium Loefl.		
Conostylidoideae T.Macfarlane & Hopper	*Conostylideae* Lindl.	*Anigozanthos* Labill.	*Anigozanthos* Labill.	*Anigozanthos* Labill.
				Ceratandri Benth.
			Haplanthesis (Benth.) Hopper	
		Blancoa Lindl.		
		Conostylis R.Br.	*Conostylis* R.Br.	*Conostylis* R.Br.
				Terraflora Hopper
			Appendicula (Geerinck) Hopper	
			Brachycaulon (Benth.) Hopper	
			Bicolorata Hopper	
			Divaricata (Hopper) Hopper	
			Pendula Hopper	
		Macropidia J.Drumm. ex Harv.		
	Phlebocaryeae Meisn.	*Phlebocarya* R.Br.		
	Tribonantheae T.Macfarlane & Hopper	*Tribonanthes* Endl.	*Tribonanthes* Endl.	
			Boya E.J.Hickman & Hopper	
			Salina E.J.Hickman & Hopper	

Annotated checklist of Haemodoraceae

Accepted names are in **bold**. Synonyms are in *italics* and roman. Arrangement of taxa is alphabetical within each rank.

Haemodoraceae R.Br., *Prodr.*: 299. (1810). *nom. cons. Type*: *Haemodorum* Sm. (1798).

Conostylidaceae Takht., *Sistema Magnoliofitov:* 313 (1987). *Type*: *Conostylis* R. Br. (1810).

Dilatridaceae M.Roem., *Handb. Allg. Bot.* 3: 476 (1840). *Type*: *Dilatris* P.J. Bergius (1767).

Wachendorfiaceae Herb., *Amaryllidaceae*: 48 (1837). *Type*: *Wachendorfia* Burm. (1757).

Xiphidiaceae Dumort., *Anal. Fam. Pl.*: 59, 61 (1829) (as Xiphideae). *Type*: *Xiphidium* Aubl. (1775).

Haemodoraceae R.Br. subfamily **Haemodoroideae**. *Type*: *Haemodorum* Sm. (1798).

Haemodoroideae Arn., *Encycl. Brit.*, ed. 7, 5: 133 (1832) (as Haemodoreae). *Type*: *Haemodorum* Sm. (1798).

Wachendorfioideae Arn., *Encycl. Brit.*, ed. 7, 5: 133 (1832) (as Wachendorfieae). *Type*: *Wachendorfia* Burm. (1757).

Haemodoraceae R.Br. tribe **Haemodoreae**. *Type*: *Haemodorum* Sm. (1798).

Haemodoreae Dumort., *Anal. Fam. Pl.*: 62 (1829); Arn., *Encycl. Brit.*, ed. 7, 5: 133 (1832).

Dilatris P.J.Bergius, *Descr. Pl. Cap.*: 9, t. 3 Figure 5 (1767).

Dilatris P.J.Bergius subg. *Dilatris. Type*: *Dilatris corymbosa* P.J.Bergius.

Dilatris corymbosa P.J.Bergius, *Descr. Pl. Cap.*: 9 (1767).

Ixia hirsuta L., *Syst. Nat.*, ed. 12: 2 (1767); *Mant. Pl.*, 27 (1767). *Wachendorfia hirsuta* L., *Syst. Nat.* ed. 12, 2, 735 (1767).

Ixia umbellata Burm.f., *Prod. Cap.*: 2 (1768). *Wachendorfia umbellata* (Burm.f.) L., *Mant. Pl.* 2, 320 (1771). *Dilatris umbellata* (Burm.f.) L.f., *Suppl. Pl.*: 101 (1782).

Dilatris ixioides Lam., *Encycl.* 2: 282 (1786).

Dilatris pillansii W.F.Barker, *J. S. Afr. Bot.* 6: 155 (1940).

Haemodorum Sm., *Trans. Linn. Soc. London* 4: 213 (1798). *Type: H. corymbosum* Vahl.

Haemodorum subg. **Haemodorum**

Haemodorum austroqueenslandicum Domin, *Biblioth. Bot.* 20(85): 527 (1915).

Haemodorum basalticum R.L.Barrett, Hopper & T. Macfarlane, *Nuytsia* 26: 114 (2015).

Haemodorum brevicaule F.Muell., *Fragm.* 1: 64 (1858).

Haemodorum brevistylum T.Macfarlane & R.L.Barrett, *Nuytsia* 36: 126 (2025).

Haemodorum capitatum R.L.Barrett & Hopper, *Nuytsia* 26: 115 (2015).

Haemodorum celsum R.L.Barrett & T.Macfarlane, *Nuytsia* 36: 128 (2025).

Haemodorum clarksonii Hopper & E.J.Hickman, *Nuytsia* 36: 155 (2025).

Haemodorum coccineum R.Br., *Prodr.*: 300 (1810).

Haemodorum corymbosum var. *gracilescens* Domin, *Biblioth. Bot.* 20(85): 528 (1915).

[*Haemodorum corymbosum* auct. non Vahl: C.G.G.J. van Steenis, *Flora Malesiana* Ser. 1, 5: 113 (1954); R.L.Specht in R.L. Specht & C.P. Mountford, *Rec. Amer.-Austral. Sci. Exped. Arnhem Land* 3: 214 (1958).]

Haemodorum collevatum T.Macfarlane & R.L.Barrett, *Nuytsia* 36: 132 (2025).

Haemodorum condensatum Hopper & R.L.Barrett, *Nuytsia* 26: 117 (2015).

Haemodorum corymbosum Vahl, *Enum. Pl.* 2: 179 (1805).

Haemodorum corymbosum var. *typicum* Domin, *Biblioth. Bot.* 20(85): 527 (1915), *nom. inval.*

Haemodorum corymbosum Vahl var. *corymbosum*

Haemodorum teretifolium R.Br., *Prodr.*: 300 (1810).

Haemodorum discolor T.Macfarlane, *Fl. Australia* 45: 464 (1987).

Haemodorum sp. A, in T.D. Macfarlane, *Fl. Perth Region* 2: 856 (1987).

Haemodorum ensifolium F.Muell., *Fragm.* 1: 64 (1858).

Haemodorum longifolium W.Fitzg., *J. Roy. Soc. W. Australia* 3: 127 (1918).

Haemodorum flaviflorum W.Fitzg., *J. Roy. Soc. W. Australia* 3: 128 (1918).

See comments in taxonomic section under *Haemodorum parviflorum*.

Haemodorum ghungalorum Hopper, *Nuytsia* 36: 160 (2025).

Haemodorum griseofuscum R.L.Barrett, M.D.Barrett & Hopper, *Nuytsia* 26: 118 (2015).

Haemodorum gracile T.Macfarlane, *Fl. Australia* 45: 464 (1987).

[*Haemodorum parviflorum* auct. non Benth.: W.V.Fitzgerald, *J. Roy. Soc. W. Australia* 3: 128 1918; C.A. Gardner, *W. Australia Forests Dept. Bull.* 32: 39 (1923).]

Haemodorum interrex R.L.Barrett & M.D.Barrett, *Nuytsia* 26: 120 (2015).

Haemodorum laxum R.Br., *Prodr.*: 300 (1810).

Haemodorum leptostachyum Benth., *Fl. Austral.* 6: 423 (1873).

Haemodorum loratum T.Macfarlane, *Fl. Australia* 45: 464 (1987).

Haemodorum macfarlanei R.L.Barrett, *Nuytsia* 26: 122 (2015).

Haemodorum paniculatum Lindl., *Sketch Veg. Swan R.*: xliv (1839).

Haemodorum strictum Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 15 (1839).

Haemodorum parviflorum Benth., *Fl. Austral.* 6: 423 (1873). *Type*: Port Darwin, NorthernTerritory, *M. Schultz* 723 *comm. R. Schomburgk* 1870 (*lecto*, here designated: K barcode K 000846214).

Haemodorum planifolium R.Br., *Prodr.*: 300 (1810).

Haemodorum simplex Lindl., *Sketch Veg. Swan R.*: xliv (1839).

Haemodorum polycephalum Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 16 (1846).

Haemodorum simulans F.Muell., *Fragm.* 7: 117 (1871).

Haemodorum sparsiflorum F.Muell., *Fragm.*7: 117 (1871).

Haemodorum subvirens F.Muell., *Fragm.*1: 63 (1858).

Haemodorum thedae R.L.Barrett, *Nuytsia* 26: 123 (2015).

Haemodorum venosum T.Macfarlane, *Fl. Australia* 45: 464 (1987).

Haemodorum subg. **Antiqua** Hopper & R.J.Sm., *Nuytsia* 36: 145 (2025). *Type*: *Haemodorum distichophyllum* Hook.

Haemodorum distichophyllum Hook., *Hooker's Icon. Pl.* 9: t. 866 (1851).

Haemodorum tenuifolium A.Cunn. ex Benth., *Fl. Austral.* 6: 423 (1873).

Haemodorum subg. **Gemina** Hopper & R.J.Sm., *Nuytsia* 36: 145 (2025). *Type*: *Haemodorum spicatum* R.Br.

Haemodorum brevisepalum Benth., *Fl. Austral.* 6: 420 (1873).

Haemodorum sandifordiae Hopper & E.J.Hickman, *Nuytsia* 36: 150 (2025).

Haemodorum spicatum R.Br., *Prodr.*: 300 (1810).

Haemodorum edule Lehm. ex Endl. in J.C.G. Lehmann, *Pl. Preiss.* 2: 15 (1846).

Lachnanthes Elliott, *Sketch Bot. S. Carolina* 1: 47 (1816). *Type*: *Lachnanthes tinctoria* (Walter ex J.F.Gmel.) Elliott [= *Lachnanthes caroliniana* (Lam.) Dandy]

Camderia Dumort., *Anal. Fam. Pl.*: 80 (1829), *nom. illeg.*

Gyrotheca Salisb., *Trans. Hort. Soc. London* 1: 327 (1812), *nom. nud.*

Heritiera J.F.Gmel., *Syst. Nat.* (ed. 13) 2(1): 113 (1791), *nom. illeg.*, non *Heritiera* Aiton, nec *Heritiera* Retz

Lachnanthes caroliniana (Lam.) Dandy, *J. Bot.* 70: 329. (1932) (as '*caroliana*').

Anonymos tinctoria Walter, *Fl. Carol.*: 68. (1788), *nom. rej.*

Dilatris caroliniana Lam., *Tabl. encycl.* 1: 127 (1791) (as 'Caroliana').

Dilatris heritiera Pers., *Syn. Pl.* 1: 54 (1805), *nom. superfl.*

Dilatris tinctoria Pursh, *Fl. Amer.* Sept. 1: 30–31 (1813 [1814]).

Gyrotheca tinctoria Salisb., *Trans. Hort. Soc. London* 1: 327 (1812); *Gyrotheca tinctorum* W.Stone, *Pl. S. New Jersey* 1: 354 (1911 [1912]), *isonym*.

Heritiera gmelinii Michx., *Fl. Bor.-Amer.* 1: 21, pl. 4 (1803), as 'Gmelini', *nom. superfl.*

Heritiera tinctorium Walter ex J.F.Gmel., *Syst. Nat.* 2: 113 (1791), *nom. superfl.*

Lachnanthes tinctoria Elliott, *Sketch Bot. S. Carolina* 1(1): 47 (1816).

Lachnanthes tinctoria var. *major* Griseb., *Cat. Pl. Cub.*: 252 (1866).

Paradilatris (Hopper ex J.C.Manning) Hopper, *Nuytsia* 36: 169 (2025).

Dilatris subg. *Paradilatris* Hopper ex J.C.Manning, *S. Afr. J. Bot.* 113: 104 (2017). *Type*: *Paradilatris viscosa* (L.f.) Hopper.

Paradilatris viscosa (L.f.) Hopper, *Nuytsia* 36: 169 (2024).

Basionym: *Dilatris viscosa* L.f., *Suppl. Pl.*: 101 (1781 [1782]).

Haemodoraceae tribe **Wachendorfieae** Dumort., *Anal. Fam. Pl.*: 61 (1829) (as Wachendorfiaceae). *Type: Wachendorfia* Burm. (1757).

Wachendorfiaceae Herb., *Amaryllidaceae*: 48 (1837). *Type: Wachendorfia* Burm. (1757).

Wachendorfioideae Arn., *Encycl. Brit.*, ed. 7, 5: 133 (1832) (as Wachendorfieae). *Type: Wachendorfia* Burm. (1757).

Barberetta Harv., *Gen. S. Afr. Pl.*, ed. 2: 377 (1868). *Type*: *Barberetta aurea* Harv.

Barberetta aurea Harv., *Gen. S. Afr. Pl.*, ed. 2: 377 (1868).

Cubanicula Hopper, J.E.Gut., E.J.Hickman, M.Pell. & R.J.Sm., *PhytoKeys* 169: 5 (2020). *Type*: *Cubanicula xanthorrhizos* (C.Wright ex Griseb.) Hopper *et al.* (≡ *Xiphidium xanthorrhizon* C.Wright ex Griseb.).

Cubanicula xanthorrhizos (C.Wright ex Griseb.) Hopper, J.E.Gut., E.J.Hickman, M.Pell. & R.J.Sm., *PhytoKeys* 169: 11 (2020).

Pyrrorhiza Maguire & Wurdack, *Mem. New York Bot. Gard.* 9(3): 318 (1957). *Type*: *Pyrrorhiza neblinae* Maguire & Wurdack.

Pyrrorhiza neblinae Maguire & Wurdack, *Mem. New York Bot. Gard.* 9(3): 318, Figure 63a–g (1957).

Schiekia Meisn., *Pl. Vasc. Gen.* 1: 397; 2: 300 (1842). *Type*: *Wachendorfia orinocensis* Kunth. [≡ *Schiekia orinocensis* (Kunth) Meisn.].

Troschelia Klotzsch & R.Schomb., *Reisen, Br.-Guiana*: 1066 (1849), *nom. nud.*

Schiekia orinocensis (Kunth) Meisn., *Pl. Vasc. Gen.* 2(12): 300 (1842).

Schiekia congesta Maury, *J. Bot. (Morot)* 3: 269, f. 12 (1889), *nom. nud.*

Schiekia flavescens Maury, *J. Bot. (Morot)* 3: 269 (1889), in *Index Kewensis Suppl.* 1 as 'Sansevieria' in error.

Schiekia orinocensis subsp. *savannarum* Maguire & Wurdack, *Mem. New York Bot. Gard.* 9(3): 320 (1957).

Wachendorfia orinocensis Kunth, *Nov. Gen. Sp.* (quarto ed.) 1(3): 319 (1816).

Xiphidium angustifolium Willd. ex Link, *Jahrb. Gewächsk.* 1(3): 73 (1820), *nom. superfl.*

Schiekia silvestris (Maas & Stoel) Hopper, E.J.Hickman, R.J.Sm. & M.Pell., *PhytoKeys* 169: 30 (2020).

Schiekia orinocensis subsp. *silvestris* Maas & Stoel in P.J.M. Maas and H. Maas-van de Kamer, *Fl. Neotrop. Monogr.* 61: 21 (1993).

Schiekia timida M.Pell., E.J.Hickman, R.J.Sm. & Hopper, *PhytoKeys* 169: 34 (2020).

Wachendorfia Burm., *Wachendorfia*: 2 (1757). *Type*: *Wachendorfia thyrsiflora* Burm.

Pedilonia C.Presl, *Pedilonia*: 1 (1829).

Wacchendorfia Burm.f., *Fl. Ind. (N. L. Burman) Prodr. Fl. Cap.*: 2, sphalm. (1768).

Wachendorffa Cothen., *Disp. Veg. Meth.* 3 (1790), *orth. var.*

Pre-Linnean synonyms:

Asphodelus Breyne, *Prodr. Rar. Pl.* [sec.]: t. 22 (1739).

Erythrobulbus Pluk., *Almagesti Botanici Mantissa* 70 (1700).

Wachendorfia thyrsiflora Burm., *Wachendorfia*: 3 (1757).

Wachendorfia elata Salisb., *Prodr. Stirp. Chap. Allerton*: 45 (1796).

Pre-Linnean synonym: *Asphodelus latifolius* Breyne, *Prodr. Rar. Pl.* [sec.]: t. 22 (1739).

Wachendorfia paniculata Burm., *Wachendorfia*: 4 (1757).

Aspidistra lurida Sieber ex C.Presl, *Flora* 12: 568 (1829), *nom. illeg.*

Asphodelus latifolius Breyn. ex Schult.f., *Syst. Veg.*, ed. 15 bis 7: 485 (1829).

Pedilonia violacea C.Presl, *Pedilonia*: 1 (1829).

Wachendorfia brevifolia Sol. ex Ker Gawl., *Bot. Mag.* 27: t. 1066 (1807).

Wachendorfia breyniana D.Dietr., *Syn. Pl.* 1: 170 (1839).

Wachendorfia graminea Thunb., *Prodr. Pl. Cap.*: 1: 12 (1794), *nom. illeg.*

Wachendorfia graminifolia L.f., *Suppl. Pl.*: 101 (1781).

Wachendorfia herbertii Sweet, *Hort. Brit.*: 400 (1826), based on *Wachendorfia paniculata* var. (i) Herbert (1826).

Wachendorfia hirsuta Thunb., *Prodr. Pl. Cap.* 1: 12 (1794). *Wachendorfia paniculata* var. *hirsuta* (Thunb.) Baker, *Fl. Cap.* 6: 2 (1896).

Wachendorfia humilis Salisb., *Prodr. Stirp. Chap. Allerton*: 45 (1796).

Wachendorfia paniculata var. *brevifolia* (Sol. ex Ker Gawl.) Baker, *Fl. Cap.* 6: 2 (1896).

Wachendorfia tenella Thunb., *Prodr. Pl. Cap.* 1: 12 (1794); *Wachendorfia paniculata* var. *tenella* (Thunb.) Baker, *Fl. Cap.* 6: 2 (1896).

Wachendorfia villosa L., *Syst. Nat.* ed. 10, 2: 864 (1759).

Wachendorfia villosa Andrews, *Bot. Repos.* 6: t. 398 (1804).

Wachendorfia laxa W.F.Barker ex Hopper, *Nuytsia* 36: 172 (2025).

Wachendorfia brachyandra W.F.Barker, *J. S. Afr. Bot.*15: 41 (1949).

Wachendorfia multiflora (Klatt) J.C.Manning & Goldblatt, *Strelitzia* 9: 709 (2000).

Babiana multiflora Klatt, *Abh. Naturf. Ges. Halle* 15: 351 (1882).

Wachendorfia parviflora W.F.Barker, *J. S. Afr. Bot.*15: 39 (1949).

Xiphidium Aubl., *Hist. Pl. Guiane* 1: 33, pl. 11 (1775). *Type*: *Xiphidium caeruleum* Aubl.

Durandia Boeckeler, *Allg. Bot. Z. Syst.* 2: 160, 173 (1896).

Tonduzia Boeckeler ex Tonduz, *Bull. Herb. Boissier* 3: 464 (1895), *nom. nud.*

Xiphidium Loefl., *Iter Hispan.*: 179 (1758), *nom. nud.*

Pelligrini *et al.* (2020: p. 42) claimed, following Maas & Maas-van de Kamer (1993), that *Xiphidium* Loefl. was the earliest publication of the generic name, citing Dorr and Wiersema (2010) as supporting this view. In a subsequent personal communication from Larry Dorr to Marco Pelligrini, Dorr (in litt. 11 Feb. 2021) highlighted that he and John Wiersema observed that Loefling (1758 pg 179) had simply listed *Xiphidium* of authors as a synonym of *Ixia* and did not describe *Xiphidium* as a new genus. The mistake was acknowledged immediately by Marco Pelligrini (in litt. 11 Feb. 2021) and plans initiated to publish a correction. Here, the correct attribution of authorship of the genus *Xiphidium* by Aublet (1775) is made.

Xiphidium caeruleum Aubl., *Hist. Pl. Guiane* 1: 33, pl. 11 (1775).

Durandia macrophylla Boeckeler, *Allg. Bot. Z. Syst.* 2: 173 (1896).

Eccremis scabra Kuntze, *Revis. Gen. Pl.* 3(3): 316 (1898).

Ornithogalum rubrum Ruiz & Pav. ex D.Don, *Edinburgh New Philos. J.* 13: 235 (1832), *nom. inval.*

Tonduzia macrophylla Boeckeler ex Tonduz, *Bull. Herb. Boissier* 3: 464 (1895), *nom. nud.*

Xiphidium albidum Lam. in J.-B. Lamarck & J.L.M. Poiret, *Tabl. Encycl.* 1: 131 (1791), *nom. superfl.*

Xiphidium album Willd., *Sp. Pl.* ed. 4, 1(1): 248 (1797).

Xiphidium caeruleum var. *albidum* Backer, *Handb. Fl. Java* 3: 80 (1924).

Xiphidium floribundum Sw., *Prodr.*: 17 (1788).

Xiphidium floribundum var. *albiflorum* Hook., *Bot. Mag.* 84: t. 5055 (1858), *nom. superfl.* (≡ *X. floribundum* Sw. var. *floribundum*).

Xiphidium floribundum var. *caeruleum* (Aubl.) Hook., *Bot. Mag.* 84: t. 5055 (1858).

Xiphidium fockeanum Miq., *Linnaea* 17: 63 (1843).

Xiphidium giganteum Lindl., *Edwards's Bot. Reg.* 32: page prior to t. 67 (1846).

Xiphidium loeflingii Mutis, *Diario* 2: 51 (1958), *nom. nud.*

Xiphidium rubrum D.Don, *Edinburgh New Philos. J.* 13: 235 (1832).

Xiphidium pontederiiflorum M.Pell., Hopper & R.J.Sm., *PhytoKeys* 169: 49 (2020).

Xiphidium xanthorrhizon C.Wright ex Griseb., *Cat. Pl. Cub.* 1: 252 (1866).

Haemodoraceae R.Br. subfamily **Conostylidoideae** T.Macfarlane & Hopper, *Fl. Australia* 45: 454 (1987). *Type*: *Conostylis aculeata* R.Br.

Haemodoraceae Tribe **Conostylideae** Lindl., *Veg. Kingdom* 153 (1847) (as Conostyleae). Amaryllidaceae R.Br. tribe Conostylideae Benth., *Fl. Austral.* 6: 425. *Type*: *Conostylis aculeata* R.Br.

Haemodoraceae Tribe *Anigozantheae* Z.H.Feng, *Plant* 13 (3) 149 (2025). Type: *Anigozanthos* Labill.

Anigozanthos Labill., *Voy. Rech. Perouse* 1: 409 [octavo edn; = 410 quarto edn] (1800). *Type*: *A. rufus* Labill.

Anigosia Salisb., *Trans. Hort. Soc. London* 1: 327 (1812). *Type*: *A. flavida* (DC.) Salisb.

Schwaegrichenia Sprengel, *Pl. Min. Cogn. Pug.* 2: 58 (1815), *nom. illeg.* – includes the type of *Anigozanthos* Labill. *Type*: *S. rufa* (Labill.) Sprengel.

Anigozanthos Labill. subg. **Anigozanthos**

Anigozanthos Labill. sect. **Anigozanthos**

Anigozanthos sect. *Dianthesis* Benth., *Fl. Austral.* 6: 442 (1873), *nom. inval. Type*: *A. rufus* Labill.

Anigozanthos rufus Labill., *Voy. Rech. Perouse* 1: 409 [octavo edn = 410 quarto edn] t. 22 (1800).

Anigozanthos tyrianthinus Hook., *Bot. Mag.* 76: t. 4507 (1850).

Schwaegrichenia rufa (Labill.) Sprengel, *Pl. Min. Cogn. Pug.* 2: 58 (1815).

Anigozanthos pulcherrimus Hook., *Bot. Mag.* 71: 4180 (1845).

Anigozanthos sect. **Ceratandri** Benth., *Fl. Austral.* 6: 442, 443 (1873) (as *Certandra)*. *Type*: *A. flavidus* Redouté.

Anigozanthos sect. *Concatenati* Hopper, *Fl. Australia* 45: 455 (1987). *Type: A. preissii* Endl.

Anigozanthos flavidus Redouté, *Les Liliacees* 3: t. 176 (1807).
Anigozanthos coccineus Lindl. ex Paxton, *Mag. Bot.* 5: 271, & tab (1839).
Anigozanthos grandiflorus Salisb., *Parad. Londin.* 2: t. 97 (1808).
Schwaegrichenia flavida (Redouté) Sprengel, *Pl. Min. Cogn. Pug.* 2: 58 (1815).
Anigozanthos flavidus Redouté var. *bicolor* Lindl., *Bot. Reg.* 24: t. 64 (1838).

Anigozanthos preissii Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 26 (1846).
Anigozanthos preissii Endl. var. *plumosus* Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 26 (1846).

Anigozanthos Labill. subg. **Haplanthesis** (Benth.) Hopper, *Fl. Australia* 45: 455 (1987).
Anigozanthos sect. *Haplanthesis* Benth., *Fl. Austral.* 6: 442, 444 (1873). *Type: A. manglesii* D.Don.

Anigozanthos bicolor Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 26 (1846).

Anigozanthos bicolor Endl. subsp. **bicolor**
Anigozanthos bicolor var. *major* Benth., *Fl. Australia* 6: 446 (1873).

Anigozanthos bicolor subsp. **exstans** Hopper, *Fl. Australia* 45: 455 (1987).

Anigozanthos condingupensis Hopper & R.J.Sm., *Nuytsia* 36: 181 (2025).
Anigozanthos bicolor Endl. var. *minor* Benth. (1873) *p.p.*, not as to type.

Anigozanthos decrescens (Hopper) Hopper, *Nuytsia* 36: 184 (2025).
Anigozanthos bicolor subsp. *decrescens* Hopper, *Fl. Australia* 45: 455 (1987).

Anigozanthos gabrielae Domin, *J. Linn. Soc., Bot.* 41: 257 (1912).

Anigozanthos humilis Lindl., *Sketch Veg. Swan R.*: xlvi (1840).
Anigozanthos minimus Lehm., *Pl. Preiss.* 2: 274 (1848).
Anigozanthos dorrienii Domin, *J. Linn. Soc., Bot.* 41: 256 (1912).

Anigozanthos humilis Lindl. subsp. **humilis**

Anigozanthos humilis subsp. **chrysanthus** Hopper, *Fl. Australia* 45: 456 (1987).

Anigozanthos humilis subsp. **grandis** Hopper, *Nuytsia* 36: 188 (2025).

Anigozanthos kalbarriensis Hopper, *Nuytsia* 2: 181 (1978).

Anigozanthos knappiorum Hopper, *Nuytsia* 36: 189 (2025).
Anigozanthos bicolor subsp. *minor* (Benth.) Hopper, *Fl. Australia* 45: 455 (1987), *p.p.*, as to type.

Anigozanthos manglesii D.Don in R.Sweet, *Brit. Fl. Gard. Ser.* 2, 6: t. 265 (1834).
Anigozanthos manglesii var. *leptophyllus* Domin, *J. Linn. Soc. Bot.* 41: 257 (1912).

Anigozanthos manglesii D.Don subsp. **manglesii**
Anigozanthos manglesii var. *flavescens* Ostenf., *Biol. Meddel. Kongel. Danske Vidensk. Selsk.* 3(2): 35 (1921).

Anigozanthos manglesii subsp. **quadrans** Hopper, *Fl. Australia* 45: 456 (1987).

Anigozanthos manglesii var. ×**angustifolius** Lindl., *Bot. Reg.* 23: t. 2012 (1837).

Anigozanthos manglesii var. ×**virescens** Ostenf., *Biol. Meddel. Kongel. Danske Vidensk. Selsk.* 3(2): 35 (1921).

Anigozanthos onycis A.S.George, *Nuytsia* 1: 367 (1974).

Anigozanthos viridis Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 25 (1846).

Anigozanthos viridis Endl. subsp. **viridis**

Anigozanthos viridis subsp. **metallicus** Hopper, *Nuytsia* 36: 192 (2025).

Anigozanthos viridis subsp. **sophrosyne** Hopper, *Nuytsia* 36: 196 (2025).

Anigozanthos viridis subsp. **terraspectans** Hopper, *Fl. Australia* 45: 456 (1987).

Anigozanthos yorlining Hopper, *Nuytsia* 36: 198 (2025).

Blancoa Lindl., *Sketch Veg. Swan R.*: xlv (1840). *Type: B. canescens* Lindl.

Blancoa canescens Lindl., *Sketch Veg. Swan R.*: xlv (1840).
Conostylis canescens (Lindl.) F.Muell., *Fragm.* 8:19 (1873).

Conostylis R.Br., *Prodr.*: 300 (1810). *Type: Conostylis aculeata* R.Br.

Conostylis R.Br. subg. **Conostylis**. *Type*: *C. aculeata* R.Br.
Conostylis sect. *Euconostylis* Benth., *Fl. Austral.* 6, 429, 434 (1873), *nom. inval.*

Conostylis R.Br. sect. **Conostylis**

Conostylis aculeata R.Br., *Prodr.*: 300 (1810).

Conostylis aculeata R.Br. subsp. **aculeata**
Conostylis aculeata var. *typica* Domin, *J. Linn. Soc., Bot.* 41: 256 (1912), *nom. inval.*
Conostylis cymosa Benth., *Fl. Austral.* 6: 439 (1873).

Conostylis aculeata subsp. **bolghinup** Hopper, *Nuytsia* 36: 208. (2025).

Conostylis aculeata subsp. **breviflora** Hopper, *Nuytsia* 2: 261 (1978).

Conostylis aculeata subsp. **bromelioides** (Endl.) J.W.Green, *Proc. Linn. Soc. New South Wales* 85: 348 (1961).
Conostylis aculeata var. *abbreviata* Domin, *J. Linn. Soc. London* 41: 255 (1912).
Conostylis aculeata var. *bromelioides* (Endl.) Ewart, *Proc. Roy. Soc. Victoria* 19: 37 (1906).
Conostylis bromelioides Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 18. (1846).

Conostylis aculeata subsp. **cygnorum** Hopper, *Fl. Australia* 45: 457 (1987).
[*Conostylis bracteata* auct. non Lindl.: S.L.Endlicher in J.G.C. Lehmann, *Pl. Preiss.*2: 16 (1846).]
Conostylis harperiana W.Fitzg., *Proc. Linn. Soc. New South Wales* 28: 106 (1903).

Conostylis aculeata subsp. **echinissima** Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis aculeata subsp. **gracilis** Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis aculeata subsp. **preissii** (Endl.) J.W.Green, *Proc. Linn. Soc. New South Wales* 85: 349 (1961).

Conostylis preissii Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 18 (1846).

Conostylis aculeata subsp. **rhipidion** J.W.Green *Proc. Linn. Soc. New South Wales* 85: 348 (1961).

Conostylis aculeata subsp. **septentrionora** Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis aculeata subsp. **spinuligera** (F.Muell. ex Benth.) Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis bracteata Lindl., *Sketch Veg. Swan R.*: xlv (1840).

Conostylis aculeata subsp. *bracteata* (Lindl.) J.W.Green *Proc. Linn. Soc. New South Wales* 85: 350 (1961).

Conostylis candicans Endl. in S.L. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 3: 20 (1839).

Conostylis candicans Endl. subsp. **candicans**

Conostylis dealbata Lindl., *Sketch Veg. Swan R*: xlv (1840).

Conostylis candicans subsp. **calcicola** Hopper, *Fl. Australia* 45: 459 (1987).

Conostylis propinqua Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 17 (1846).

Conostylis dealbata var. *sarmentosa* Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 17 (1846).

Conostylis candicans subsp. **flavifolia** Hopper, *Fl. Australia* 45: 459 (1987).

Conostylis candicans subsp. **procumbens** Hopper, *Fl. Australia* 45: 459 (1987

Conostylis festucacea Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 18 (1846).

Conostylis festucacea Endl. subsp. **festucacea**

Conostylis festucacea subsp. **filifolia** (F.Muell.) Hopper, *Fl. Australia* 45: 460 (1987).

Conostylis filifolia F.Muell., *Fragm.* 8: 18 (1873).

Conostylis misera Endl. In J.G.C. Lehmann, *Pl. Preiss.* 2: 22 (1846).

Conostylis gladiata Benth., *Fl. Austral.* 6: 434 (1873).

A case could be made for placing *C. misera* in a monotypic section sister either to *C.* section *Conostylis* or *C.* section *Terraflora*. However, current molecular evidence on sister relationships is equivocal (Hopper *et al.* 2006). Further research is recommended.

Conostylis pauciflora Hopper, *Nuytsia* 2: 258 (1978).

Conostylis pauciflora Hopper subsp. **pauciflora**

Conostylis pauciflora subsp. **euryrhipis** Hopper, *Fl. Australia* 45: 461 (1987).

Conostylis prolifera Benth., *Fl. Austral.* 6: 436 (1873).

Conostylis racemosa Benth., *loc. cit.*

[*Conostylis stylidioides* auct. non F.Muell.: J.W. Green, *Proc. Linn. Soc. New South Wales* 85: 352 (1961). *p.p.* as to green-leaved specimens.]

Conostylis robusta Diels in L. Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 109 (1904).

Conostylis aculeata subsp. *robusta* (Diels) J.W.Green, *Proc. Linn. Soc.* New South Wales 85: 348 (1961).

Conostylis robusta Diels subsp. **robusta**

Conostylis robusta subsp. **hickmaniae** Hopper, *Nuytsia* 36: 214 (2025).

Conostylis seorsiflora F.Muell., *Fragm.* 1: 158 (1859).

Conostylis seorsiflora F.Muell. subsp. **seorsiflora**

Conostylis seorsiflora subsp. **longissima** Hopper, *Fl. Australia* 45: 462 (1987).

Conostylis seorsiflora subsp. **trichophylla** Hopper, *Fl. Australia* 45: 462 (1987).

Conostylis stylidioides F.Muell., *Fragm.* 8: 17 (1872).

Conostylis sect. **Terraflora** Hopper, *Nuytsia* 36: 202 (2025). *Type*: *C. serrulata* R.Br.

Conostylis glabra Hopper, *Nuytsia* 36: 202 (2025).

Conostylis juncea Endl. in S.L. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 3: 19 (1839).

Conostylis involucrata Endl. in J.G.C. Lehmann, *Pl. Preiss.*2: 23 (1846).

Conostylis juncea var. *involucrata* (Endl.) Ostenf., *Dec. Kg. Danske Vidensk. Selsk. Biol. Meddel.* 3: 32 (1921).

Conostylis laxiflora Benth., *Fl. Austral.* 6: 439 (1873).

Conostylis magna Hopper, *Nuytsia* 36: 205 (2025).

Conostylis serrulata R.Br., *Prodr.*: 300 (1810).

Northern populations have inner sides of perianth lobes with prominently gold and white colouration, whereas southern (typical) populations tend to gold and creamy gold colouration. Possibly subspecies could be recognised?

Conostylis subg. **Appendicula** (Geerinck) Hopper, *Nuytsia* 36: 201 (2025).

Conostylis sect. *Appendicula* Geerinck, *Bull. Jard. Bot. Etat.* 39: 64 (1969). *Type*: *C. aurea* Lindl.

Conostylis angustifolia Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis aurea Lindl., *Sketch Veg. Swan R.*: xliv (1840).

Conostylis sulphurea Endl. in J.G.C. Lehmann, *Pl. Preiss.*2: 17 (1846).

Conostylis hiemalis Hopper, *Fl. Australia* 45: 460 (1987).

Conostylis resinosa Hopper, *Fl. Australia* 45: 461 (1987).

Conostylis aurea var. *longiscapa* Ewart, *Proc. Roy. Soc. Victoria* 19(2): 37 (1906).

Conostylis seminuda Hopper, *Fl. Australia* 45: 462 (1987).

Conostylis tomentosa Hopper, *Fl. Australia* 45: 463 (1987).

Conostylis subg. **Brachycaulon** (Benth.) Hopper, *Fl. Australia* 45: 457 (1987).

Conostylis sect. *Brachycaulon* Benth., *Fl. Austral.* 6:428, 430 (1873). *Type*: *C. breviscapa* R.Br.

We have retained this subgenus to minimise nomenclatural change pending further molecular studies. Present evidence (Hopper *et al.* 2006) indicates that the subgenus forms a moderately supported early branching clade with *C.* subg. *Bicolorata* and *C.* subg. *Divaricata* that is sister to *C.* subg. *Pendula.*

Conostylis breviscapa R.Br., *Prodr.*: 301 (1810).

Conostylis subg. **Bicolorata** Hopper, *Fl. Australia* 45: 456 (1987). *Type*: *C. vaginata* Endl.

We have retained this subgenus to minimise nomenclatural change pending further molecular studies. Present evidence (Hopper *et al.* 2006) indicates that the subgenus forms a moderately supported early branching clade with *C.* subg. *Brachycaulon* and *C.* subg. *Divaricata* that is sister to *C.* subg. *Pendula.*

Conostylis vaginata Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 23 (1846).

Conostylis subg. **Divaricata** (Hopper) Hopper, *Nuytsia* 36: 202 (2025).

Conostylis sect. *Divaricata* Hopper, *Fl. Australia* 45: 457 (1987). *Type*: *C. phathyrantha* Diels

We have retained this taxon and upgraded it to subgenus for consistency to minimise nomenclatural change pending further molecular studies. Present evidence (Hopper *et al.* 2006) indicates that the subgenus forms a moderately supported early branching clade with *C.* subg. *Bicolorata* and *C.* subg. *Brachycaulon* that is sister to *C.* subg. *Pendula.*

Conostylis phathyrantha Diels in L. Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 111 (1904).

Conostylis subg. **Pendula** Hopper, *Fl. Australia* 45: 457 (1987). *Type*: *C. setigera* R.Br.

Androstemma Lindl., *Sketch Veg. Swan R.*: xlvi (1840). *Type: C. androstemma* F.Muell.

Conostylis subg. *Androstemma* (Lindl.) Hopper, *Fl. Australia* 45: 456 (1987).

Conostylis subg. *Greenia* (Geerinck) Hopper, *Fl. Australia* 45: 457 (1987). *Type*: *C. bealiana* F. Muell.

This is the largest subgenus with 25 species. Several groups display chromosome dysploidy and polyploidy. Not a single interspecific hybrid has been collected from the subgenus. The inclusion of five species with elongate perianths perhaps indicative of vertebrate pollination in the subgenus (*C. androstemma, C. argentea, C. bungalbin, C. bealiana, C. albescens*) is based on molecular studies (Hopper *et al.* 2006).

Conostylis albescens Hopper, *Fl. Australia* 45: 458 (1987).

Conostylis androstemma F.Muell., *Fragm.* 8: 19 (1873).

Conostylis androstemma subsp. *androstemma.*

Conostylis argentea (J.W.Green) Hopper, *Fl. Australia* 45: 459 (1987).

Conostylis androstemma subsp. *argentea* J.W.Green, *Proc. Linn. Soc. New South Wales* 85: 367 (1961).

Conostylis bealiana F.Muell., *Fragm.* 9: 50 (1875).

Conostylis bungalbin Hopper, *Nuytsia* 36: 210 (2025).

Conostylis canteriata Hopper, *Fl. Australia* 45: 459 (1987).

Conostylis caricina Lindl., *Sketch Veg. Swan R.*: xlv (1840).

Conostylis caricina Lindl. subsp. **caricina**
Conostylis graminea Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 19 (1846).

Conostylis caricina subsp. **elachys** Hopper, *Fl. Australia* 45: 460 (1987).

Conostylis crassinerva J.W.Green, *Proc. Linn. Soc. New South Wales* 85: 361 (1961).

Conostylis crassinerva J.W.Green subsp. **crassinerva**

Conostylis crassinerva subsp. **absens** Hopper, *Fl. Australia* 45: 460 (1987).

Conostylis dasys (Hopper) Hopper, *Nuytsia* 36: 213 (2025).
Conostylis setigera subsp. *dasys* Hopper, *Fl. Australia* 45: 463 (1987).

Conostylis deplexa J.W.Green, *Nuytsia* 4: 55 (1982).

Conostylis dielsii W.Fitzg., *J. Proc. Mueller. Bot. Soc. W. Australia* 1: 82 (1903).

Conostylis dielsii W.Fitzg. subsp. dielsii

Conostylis dielsii subsp. **teres** Hopper, *Fl. Australia* 45: 460 (1987).

Conostylis drummondii Benth., *Fl. Austral.* 6: 433 (1873).

Conostylis latens Hopper, *Fl. Australia* 45: 461 (1987).

Conostylis lepidospermoides Hopper, *Fl. Australia* 45: 461 (1987).

Conostylis micrantha Hopper, *Fl. Australia* 45: 461 (1987).

Conostylis neocymosa Hopper, *Bot. Not.* 133:224 (1980).
Conostylis cymosa Benth., *Fl. Austral.* 6: 439 (1873). *p.p.*, not as to lectotype.

Conostylis petrophiloides F.Muell. ex Benth., *Fl. Austral.* 6: 431 (1873).

Conostylis pusilla Endl. in J.G.C.Lehmann, *Pl. Preiss.* 2: 20 (1846).
Conostylis minima Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 21 (1846).

Conostylis rogeri Hopper, *Fl. Australia* 45: 462 (1987).

Conostylis setigera R.Br., *Prodr.*: 300 (1810).
This species includes a polyploid complex in need of further taxonomic revision.
Conostylis aemula Lindl., *Sketch Veg. Swan R.*: xlv (1840).
Conostylis assimilis Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 20 (1846).
Conostylis discolor Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 20 (1846).
Conostylis melanopogon Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 18 (1846).
Conostylis melanopogon var. *major* Benth., *Fl. Austral.* 6: 432 (1873).

Conostylis psyllium Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 21 (1846).

Conostylis setosa Lindl., *Sketch Veg. Swan R.*: xliv (1840).

Conostylis teretifolia J.W.Green, *Proc. Linn. Soc. New South Wales* 85: 360 (1961).

Conostylis teretifolia J.W.Green subsp. **teretifolia**

Conostylis teretifolia subsp. **planescens** Hopper, *Fl. Australia* 45: 463 (1987).

Conostylis teretiuscula F.Muell., *Fragm.* 8: 18 (1873).

Conostylis villosa Benth., *Fl. Austral.* 6: 433 (1873).

Conostylis wonganensis Hopper, *Nuytsia* 4: 17 (1982).

Macropidia J.Drumm. ex Harv., *Hooker's J. Bot. Kew Gard. Misc.* 7: 57 (1855). *Type*: *Macropidia fuliginosa* (Hook.) Druce.

Macropidia fuliginosa (Hook.) Druce, *Bot. Soc. Exch. Club Brit. Isles* 1916: 634 (1917).
Anigozanthos fuliginosus Hook., *Bot. Mag.* 73: t. 4291 (1847).0
Macropidia fumosa J.Drumm. ex Harv., *Hooker's J. Bot. Kew Gard. Misc.* 7: 57 (1855).

Haemodoraceae Tribe **Phlebocaryeae** Meisn., *Pl. Vasc. Gen.* 1: 396 (1842). *Type*: *Phlebocarya ciliata* R.Br.

Phlebocarya R.Br., *Prodr.*: 301 (1810). *Type*: *P. ciliata* R.Br.

Phlebocarya ciliata R.Br., *Prodr.*: 301 (1810).

Phlebocarya filifolia (F.Muell.) Benth., *Fl. Austral.* 6: 425 (1873).
Phlebocarya ciliata var. *filifolia* F.Muell., *Fragm.* 8: 23 (1873).

Phlebocarya pilosissima (F.Muell.) Benth., *Fl. Austral.* 6: 425 (1873).
Phlebocarya ciliata var. *pilosissima* F.Muell., *Fragm.* 8: 23 (1873).

Phlebocarya pilosissima (F.Muell.) Benth. subsp. **pilosissima**

Phlebocarya pilosissima subsp. **teretifolia** T.Macfarlane, *Fl. Australia* 45: 465 (1987).

Haemodoraceae Tribe **Tribonantheae** T.Macfarlane & Hopper, *Fl. Australia* 45: 454 (1987). *Type*: *Tribonanthes* Endl.

Tribonanthes Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839). *Type*: *Tribonanthes australis* Endl.

Tribonanthes Endl. subg. **Tribonanthes**

Tribonanthes australis Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839).

Tribonanthes brachypetala Lindl., *Sketch Veg. Swan R.*: xliv. (1840).
Tribonanthes odora Endl., in J.G.C. Lehmann, *Pl. Preiss.* 2: 28 (1846), *nom. illeg., nom. superfl.*

Tribonanthes elongata E.J.Hickman & Hopper, *Nuytsia* 30: 125 (2019).

Tribonanthes keigheryi E.J.Hickman & Hopper, *Nuytsia* 30: 129 (2019).

Tribonanthes longipetala Lindl., *Sketch Veg. Swan R.*: xliv (1840).

Tribonanthes monantha E.J.Hickman & Hopper, *Nuytsia* 30: 115 (2019).

Tribonanthes porphyrea E.J.Hickman & Hopper, *Nuytsia* 30: 119 (2019).

Tribonanthes uniflora Lindl., *Sketch Veg. Swan R.*: xliv (1840).

Tribonanthes variabilis Lindl., *Sketch Veg. Swan R.*: xliv. (1840).

Tribonanthes violacea Endl. in J.G.C. Lehmann, *Pl. Preiss.* 2: 28. (1846).

There seem to be significant genetic differences between northern and southern populations. Further taxonomic research is recommended.

Tribonanthes subg. **Boya** E.J.Hickman & Hopper, *Nuytsia* 30: 145 (2019). *Type*: *Tribonanthes purpurea* T.Macfarlane & Hopper.

Tribonanthes purpurea T.Macfarlane & Hopper, *Fl. Australia* 45: 465 (1987).

Tribonanthes subg. **Salina** E.J.Hickman & Hopper, *Nuytsia* 30: 144 (2019). *Type*: *Tribonanthes minor* M.Lyons & Keighery.

Tribonanthes minor M.Lyons & Keighery, *Nuytsia* 16: 78 (2006).

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Referees for Volume 36

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